welcome to the

ENDANGERED SPECIES HANDBOOK

Animal Welfare Institute

Endangered Species Handbook

Chapters:

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Endangered Species Handbook

"Dodo oder Dronte (Didus Ineptus)"
by F. John (1890)

It's Too Late:

It's Too Late

http://www.endangeredspecieshandbook.org/dinos_invertebrates.php

Introduction

Skeptics ask why it should matter whether the tiger (*Panthera tigris*) or other endangered species become extinct. Aren't all extinctions natural events? Yet enormous differences exist between the extinctions of the dinosaurs and other animals that faded out eons ago and those of recently disappeared species. Dinosaurs proliferated into a great diversity of species and dominated other life over a period of many years. Some dinosaur families endured tens of millions of years on Earth Œ others far less Œ before fading into extinction. It is difficult to grasp the reality of their immense sojourn, as some species existed for only a hundred thousand years. The Ornithischia, one major group of dinosaurs, had an enormous number of living species 135 million years ago at the dawn of the Cretaceous Period, but slowly died out over the next 60 million years. The last of the line became extinct some 65 million years ago as the last of the dinosaurs expired.

Extinctions of dinosaurs and millions of other species that disappeared from Earth at that time were natural in origin. These extinctions had many causes; changes in climate resulting from meteors colliding with Earth may have killed off the last dinosaurs. Many scientists believe the impact raised a dust cloud that blocked sunlight and reduced the enormous amounts of vegetation needed by the dinosaurs, and it may have cooled the climate as well. Another major cause of ancient extinctions was the movement of the Earth's tectonic plates, which broke up huge land masses into smaller ones. Some species became isolated on islands too small for their habitat requirements, and stronger species caused the extinctions of weaker or less adaptable species when continents were joined. Continents and islands moved into different climate zones as well. The Earth's climate and atmosphere have undergone major changes over the ages and species that could not adapt have fallen into extinction. Volcanic eruptions have spurred extinctions by inundating land with lava and cooling the climate with dust. Islands produced by volcanic eruptions have risen from ocean bottoms, become covered with vegetation and home to unique wildlife, only to sink into the sea some time later.

In the past, ecological roles left empty by extinctions were soon filled by the evolution of new species. After the last of the dinosaurs died out some 65 million years ago, mammals and other animals proliferated on Earth. The overall diversity of species remained stable or increased. At present, however, diversity of life on Earth is in steep decline as species are dying out without being replaced.

The Recent Picture: A Rapid Rise in Extinctions

The current extinction rate is estimated to be up to a thousand times higher than prehistory rates (Leakey and Lewin 1995, Stearns and Stearns 1999). This phenomenon has been described as the sixth wave of extinctions by scientists Richard Leakey and Roger Lewin Œ ecosystems are being disrupted around the world, and the wondrous tapestry of living things that supports human existence is unraveling.

Since 1500, approximately 375 species of invertebrates, 81 species of fish (Hilton-Taylor 2000) and 291 species of mammals, birds, reptiles and amphibians (see Appendix) have become extinct. About three-fourths of vertebrates other than fish have disappeared since 1800, while only 80 species died out in the previous three centuries. These figures represent a minimum number. An estimated 5 million species of animals and plants exist in tropical rainforests, a conservative figure that may apply to insects alone, according to biologist Edward O. Wilson (1988). About half of these species are restricted or localized in distribution (Wilson 1988). With this in mind, at the present

rate of destruction of tropical forests, some 17,500 species are being lost per year Œ a rate 1,000 to 10,000 times greater than extinction rates prior to human intervention (Wilson 1988).

Human activity lies at the root of this potentially catastrophic phenomenon. Killing for food or sport, as well as conditions created by humans, such as habitat destruction and competition, predation and disease from introduced animals, is responsible for the vast majority of these extinctions. It is with this perspective that we can see the present situation as an *unnatural* event, not linked to climatic changes, meteors or volcanic eruptions, but a result of human-caused changes wrought in the Earth's environments and by direct extermination.

Plants

Extinctions of plants and trees can have a direct impact on human society. A sap found in 1997 by Dr. John Burley, research director of Harvard University's Arnold Arboretum, was tested by the National Cancer Institute and determined to be 100 percent effective in preventing cell replication of the AIDS virus (Stocker 1996). The plant sample came from an ancient swamp forest tree in Sarawak, a Malaysian state on the island of Borneo. When Dr. Burley returned to the spot a year later for another specimen from the tree, only a stump remained, and no other trees of the same species could be found (Stocker 1996). The substance is being reproduced synthetically, but it is not known whether it will be as effective as the original compound (Stocker 1996).

Sarawak's forests grew undisturbed for 180 million years, but they are now rapidly disappearing along with the rest of Borneo's ancient forests. Commercial loggers have felled tens of thousands of these old growth, towering trees in Indonesia and other tropical rainforests for the manufacture of disposable packing crates and chopsticks for Japanese and Chinese markets. Borneo's forests are also being consumed by fires set by wealthy landowners to clear land for palm plantations, or by settlers for farmland, eliminating an untold number of plants. Some tropical tree species have wide distributions over thousands of square miles, but many occupy extremely small areas. This was dramatically illustrated in the disappearance of this tree. Thousands of compounds that could cure diseases or be of great economic and ecological importance may be lost on a daily basis as the world's forests are destroyed at this unprecedented rate.

Plant extinctions have accelerated in the past few centuries. An estimated 5,050 taxa of plants, including species, varieties and other taxonomic groups, have become extinct worldwide since 1700, according to Ghillean T. Prance of the Royal Botanical Gardens Kew (Prance 1990). This implies at least 17 plants have been lost per year since 1700. Yet however high this rate appears to be, it is probably a low estimate. A 1998 study by botanists Kerry S. Walter and Harriet J. Gillett for the International Union for the Conservation of Nature (IUCN) found that 380 species, a number that does not include varieties and other taxa, have recently become extinct. These authors admit their extinction total may be low as a result of lack of data, and they did not define the time period covered.

· The data lacks exact numbers of plant extinctions. Plants rarely leave signs of their existence as vertebrates do, since bones are the basis of much data on animal extinctions. Non-woody plants, which make up the majority of plants, leave little trace when they die, and are soon consumed by microbes. This is especially true in tropical areas, where plant matter is consumed very quickly. We know of ancient plants by chance events, such as the preservation of pollen grains or other plant parts in peat, mud, amber or fossilized stone. When numbers of plant extinctions are estimated, the diversity and status of habitat are important considerations. Moreover, only a small percentage of all plants have been scientifically described. What is known is a great many regions of the Earth that once had very diverse endemic plants have been destroyed within the past few centuries, and a majority was not thoroughly assessed.

Botanical wealth is often discovered and destroyed soon after. In Ecuador's mountain ridges, botanists Al Gentry and Calaway Dodson of the Missouri Botanical Garden in St. Louis discovered many unique plants in 1978 on a crest

known as Centinela Ridge in a 20 square kilometer cloud forest in the foothills of the Andes. Among the plants were 38 endemic species, many of which were unusually dark•leafed (Forsyth 1990). The two scientists found a total of 90 related plants growing under the forest canopy with epiphytic plants, such as bromeliads and orchids, on the trunks and branches of the trees (Wilson 1992). These cloud forests and paramos Œ treeless, mossy areas in the northern Andes Œ are centers for unique species. At the time they discovered the plants, Gentry and Dodson observed farmers from the valley below clearing the forests, as they have done on 96 percent of the Pacific ridges of the Andes (Wilson 1992). Gradually, the clearing moved up to Centinela Ridge. By 1986, the botanical oasis had disappeared; in its place were cacao and other crops (Wilson 1992). These lost species might have provided compounds to treat cancers, or been an ancestor of an agricultural plant, such as a perennial tomato, but they exist now only as pressed specimens taken by the botanists.

Near Centinela Ridge is Rio Palenque; once an extensive cloud forest, it is now diminished. It was among the most botanically diverse forests in the world Š 600 species per square kilometer (Forsyth 1990). Ornithologists and birdwatchers came from all over to see the 336 bird species of Palenque's diverse habitats (Forsyth 1990). The endangered harpy eagle was one spectacular native bird that disappeared when the forest was cleared (Forsyth 1990).

Cloud forests are found in tropical Asia, Africa and Latin America. These ecosystems shelter such rarities as the iridescent green and red resplendent quetzal of Central America, but this ecosystem has nearly disappeared. An impressive variety of orchids, mosses and dwarf trees grow in these misty, cool environments. Should global warming continue, cloud forests will be among the first type of forest to disappear altogether, extinguishing thousands of unique life forms in the process.

Introduction of alien species of plants can overwhelm native species and cause their extinction (Prance 1990). In Indonesia, a type of non-native grass called imperata (*Imperata cylindrica*) grows aggressively in deforested areas, spreading into forests. Once established, imperata obstructs the regeneration of native plants and trees (Prance 1990), many of which exist nowhere else. Imperata has also displaced endemic plants in other parts of the world. In Australia, exotic plants are a major factor; they have eliminated at least 117 plant taxa and endangered another 1,931 (Prance 1990). Ironically, native Australian plants have caused extinctions after they became established in parts of South Africa and the Florida Everglades.

Plants have also disappeared as a result of pollution in the form of acid rain caused by power plant emissions, heavy metal (especially lead) accumulations and other toxins in the air (Prance 1990). Forests in North America and Eurasia have been susceptible to pollution, and in some areas, all forms of vegetation have died out.

Livestock overgrazing is responsible for the extinctions of countless plants, and endemic island species are among the most vulnerable. Such plants may occupy only a few acres. The South Atlantic island of St. Helena lost at least 10 kinds of endemic trees after the introduction of goats onto the island in 1513; the St. Helena redwood (*Trochetia erythroxylon*) became reduced to a single tree in the wild (Prance 1990). Fortunately, it was saved by propagation at the Royal Botanic Gardens Kew in London and cultivated specimens have been reintroduced (Prance 1990). The sandalo (*Drypetes caustica*), a fragrant type of sandalwood tree that once grew abundantly on the island of Juan Fernandez, the site of *Robinson Crusoe*, became extinct by 1916 after centuries of heavy logging and destruction of seedlings by goats (Prance 1990).

The Mascarene Islands, east of Madagascar in the southern Indian Ocean, have been the scene of many plant extinctions. One of the three main islands, Mauritius, was home to the famous dodo. Ebony once covered the plains and mountain slopes of this island, but during colonization of the islands from the early 17th century onward by Holland, France and Britain, extraction of a huge volume of timber denuded valleys and all accessible places (Parnell *et al.* 1986). As early as 1671, Mauritius had appointed a chief woodcutter to oversee the cutting of the island's forests. Unfortunately, this had little effect on forest clearance. Of the dense tropical evergreen forests that once covered the lowlands, only a few patches remain in inaccessible areas. Trees 20 meters or more in height grew in the uplands of the island, their branches heavy with thick growths of lianas and orchids. On the ground, ferns and mosses

sprung up luxuriantly.

Today, only a single tract remains of this habitat, the Black River Gorges reserve (Sayer *et al*. 1992). By 1874, these islands, once described as verdant "earthly paradises," were dry and comparatively barren, with a vegetation composed mainly of weeds (Parnell *et al*. 1986). Only about 30 square kilometers of Mauritius forest survives since 93 percent was destroyed (Sayer *et al*. 1992). The mangrove forests that once lined Mauritius' shores have disappeared along the West Coast because they were cut for firewood. Rodrigues, a small island off the coast of Mauritius that was once a wildlife haven, lost virtually all its forests. Reunion, the third island, was also settled and heavily logged. About 61 percent of its forests, including virtually all its lowland forests, have been cleared; only 100 square kilometers remain (Sayer *et al*. 1992). A few remnants of montane forest have been protected by the French government, which controls the island.

Mauritius, Rodrigues and Reunion have lost many native plant species. Of 1,296 native plants, 53 species are extinct and 393 of the surviving species are threatened, according to the *1997 IUCN Red List of Threatened Plants* (Walter and Gillett 1998). Little remains of its ebony forests, and eight ebony tree species are virtually extinct (Simon 1995). The islands have lost six of their beautiful orchid species, and 13 more are threatened (Walter and Gillett 1998). Mauritius and Rodrigues have been described as the "Islands of the Living Dead" by authors Beverly and Stephen Stearns because at least 30 plant species have ceased reproducing in the wild, living on the edge of extinction (Stearns and Stearns 1999). One, *Ramosmania heterophylla*, described in 1874, was not seen again until 1982 when botanist Wendy Strahm found the last specimen growing by a roadside. She fenced it off to protect it, only to learn this made local people consider it a "magic plant" that cured all diseases and maladies (Stearns and Stearns 1999). They cut off small pieces Š despite its fencing Š and have nearly obliterated it. Luckily Strahm took cuttings and sent one to Kew Gardens in England for propagation; it now grows there, but does not seed because the plant is defective (Stearns and Stearns 1999). A critically endangered tree, *Elaeocarpus bojeri*, native to Mauritius, has delicate, bell-like flowers with a scalloped fringe. Strahm's photograph illustrating these flowers appears on the cover of the *1997 IUCN Red List of Threatened Plants* (Walter and Gillett 1998). It epitomizes the status of many Mascarene plants in need of dramatic rescue programs, as well as the need to prevent extinctions, such as that of a rare Rodrigues tree hibiscus (*Hibiscus liliflorus*); the species became extinct in 1982 after it was reduced to a single plant growing on the top of a mountain (Stearns and Stearns 1999).

Two endangered native wild coffee plants of Mauritius (*Coffea macrocarpa* and *Coffea myrtifolia*) might invigorate domestic species stricken with disease if they are protected from extinction, illustrating another reason to preserve native plants. The wild ancestors of domestic grains and crops retain many characteristics lost in cultivated varieties, such as resistance to drought, insects and disease. An outbreak of cornleaf blight in the United States in 1970 cost farmers almost $1 billion, and the disease was not halted until a wild corn species was interbred with the domestic strain (Fenyvesi 1995). A perennial variety of maize (wild corn) found in a Mexican forest could be hybridized with domestic corn to save farmers from replanting each year. Other crops saved by crossbreeding with tropical forest wild stock include sugarcane, coffee, cocoa and banana (Schreiber *et al*. 1989). Yet with the accelerating rate of plant extinctions and destruction of native plant ecosystems, many such ancestor species may be lost.

All ecosystems are plant-based. Plants produce oxygen, making life on Earth possible, and perform a vital task for other life forms by absorbing vast amounts of toxins and carbon dioxide. They are the source of thousands of important medicines, and discoveries of new medicinal uses of plants are being made on a regular basis. Disappearance of individual species of plants can impoverish or even collapse entire ecosystems when they are key to the survival of many species of animals or form an intrinsic link in an ecosystem.

Not only do many plants fade to extinction undocumented by botanists, but only a small percentage of living plants have been scientifically described. Botanists have identified more than 250 thousand types of living plants other than algae, fungi and bacteria, but most scientists agree these represent perhaps a tenth of all living plants. Almost 10 percent of surviving species are considered threatened with extinction. Some 34 thousand plant species are listed in

the *1997 IUCN Red List* (Walter and Gillett 1998). Many of these plants have not been seen for years and may be declared extinct in the near future, or are clinging to life with only a few individuals left. Preservation of the planet's great diversity of plants to prevent further extinctions should be a priority of the first order.

Invertebrates

Invertebrates are key members of many ecosystems. Insects pollinate plants, while mollusks and gastropods form the basis of many aquatic food chains. Documentation of invertebrate extinctions is incomplete, but a minimum of 375 species (approximately eight crustaceans, 72 insects, 31 bivalves and 260 gastropods, snails and related species) have become extinct worldwide in the past few hundred years, according to the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000). Massive destruction of many habitats, especially islands with endemic species such as land snails, has eliminated hundreds of these creatures.

Extinct bivalves include mollusks native to the southeastern United States, the world's center of diversity for freshwater mussels. Dam construction turned clear, fast-flowing rivers into still ponds, destroying prime mussel habitat. Channelization, in which the natural curves of a river are straightened and its surrounding vegetation bulldozed from its banks, wreaked havoc in aquatic ecosystems. Biologically rich rivers became muddy, sterile ditches. These government-sponsored anti-flood programs took place during the first half of the 20th century, causing numerous extinctions of mussels and crayfish.

At the time, few people lamented the disappearance of these mussels, some of which were the size of dinner plates. They grew in huge masses on river bottoms, serving as keystone species in river ecosystems by providing habitats for fish, crayfish and huge river snails. Birds and aquatic mammals fed on the fish and other aquatic wildlife produced by these mussels; these large bivalves also cleansed the water with their filtering gills. Water pollution from industry and coal mining and sedimentation from logging have contributed to their extinction. Additionally, mussels are over-harvested because of their commercial value in the cultured pearl industry Œ their shells are harvested and broken into tiny pieces that are inserted into living oysters to stimulate the growth of pearls. These combined threats have pushed many species to extinction and others to endangered status. Their demise has caused species dependent on mussels for reproduction and habitat to disappear as well.

Scores of colorful endemic land snail species have died out in the Hawaiian Islands, other Polynesian and Indian Ocean islands and various southern Atlantic Ocean islands. These snails were once prolific in native forests, but naturalists and shell collectors took many thousands of them during the 19th century Œ until the 1920s, when it became too difficult to find them (Stearns and Stearns 1999). One individual, J.T. Gulick, the son of Hawaiian missionaries, "ransacked" the islands for tens of thousands of these colorful land snails, collecting 44,500 in three years (Stearns and Stearns 1999). He alone caused the extinction of numerous species on the islands by encouraging rural residents to collect for him and by buying shells by the thousands, believing himself to be an important naturalist. He was among the collectors who scoured the woods where these shells clung to trees and low bushes by the hundreds (Stearns and Stearns 1999). Many were striped, while others were solid shades of ivory, yellow-gold and deep brown. Some collections were of no scientific value because the locations where they were obtained were not noted. No similar species remain in the wild today (Stearns and Stearns 1999).

In more recent times, exotic species of snails have been introduced onto islands for various purposes, preying on the native species. One expert estimated that when Captain Cook arrived in Hawaii in 1778, there were between 800 and 1,000 species of endemic Hawaiian snails from 11 families, but at present, only about 200 remain (Stearns and Stearns 1999). Recent extinctions have been caused by deforestation and predation by exotic snails, including the giant African snail, introduced by the Hawaii Department of Agriculture to prey on another exotic snail. Native snails

feed mainly in endemic Hawaiian trees, another reason they have failed to adapt to the introduction of exotic trees and bushes. Unusual among invertebrates, these snails reproduce slowly, one species needing 19 years just to replace itself (Stearns and Stearns 1999). At least 49 species have become extinct in recent times, according to the Nature Conservancy's book, *Precious Heritage: the Status of Biodiversity in the United States* (Stein *et al*. 2000). The remaining species of Hawaiian land snail are endangered, and species are disappearing regularly from the wild, preyed on by exotic snails or rats and losing their host trees to logging (Stearns and Stearns 1999). Conservation programs have not been well-funded, as these are among the least well-known of Hawaiian wildlife.

On the island of Moorea in the Society Islands, the giant African snail was introduced as a food source, but when it became overpopulated, a carnivorous snail, *Euglandia rosea*, was introduced to prey on it. Instead, the latter species preyed voraciously on native tree snails, exterminating all 11 species; it is now in the process of eliminating the native snails of Tahiti (Wilson 1992).

Butterfly populations have declined from loss of host plants, pesticide use, over-collecting and loss of species upon which they depend. The Xerces Blue (*Glaucopsyche xerces*) is the only native species in the United States to have become extinct in recent times. It disappeared in the early 1940s, and the Xerces Society, dedicated to preserving butterflies, was named after it. It is one of 38 butterfly species that recently disappeared around the world (Baillie and Groombridge 1996).

Invertebrates play key roles in many of the world's ecosystems as food sources, for people as well as animals. Some, such as coral and mollusks, create habitats for thousands of species. Butterflies, mollusks and snails are among the planet's most beautiful creatures, yet conservation programs often neglect these important species.

Vertebrates

Vertebrate extinctions worldwide since 1500 total at least 372 species of mammals, birds, reptiles, amphibians and fish. The largest number Œ 157 species Œ were birds, while 100 mammal species, 28 reptile species, 6 amphibians and 81 fish species disappeared. The number and rate of extinctions have increased gradually in recent centuries, as the table "Extinct Species of Birds, Mammals, Reptiles and Amphibians" illustrates. Fewer than 80 of these vertebrates became extinct from 1500 through the 18th century, while in only the 19th century, 98 species of birds, mammals and reptiles died off. The rate accelerated during the 20th century; based on incomplete information, at least 115 vertebrates Š already 17 species more than in the past century Š were lost. (See Appendix for list of species and their dates of extinctions.) This total will be far greater when the toll for the 20th century is finalized.

229 species, almost 80 percent of the 291 extinct mammals, birds, reptiles and amphibians, were native to islands, mostly located far from the nearest land mass, such as the Hawaiian Islands, Mascarene Islands and New Zealand. (See Table fiThe Geography of Extinction.fl) Many of these island species were distinctive and unusual, the products of thousands and even millions of years of evolution in isolation. Few left close relatives.

Some islands are fragments of ancient continents, broken off more than 100 million years ago, with resident wildlife and plants. New Zealand, Madagascar, the Seychelles and the larger islands of the Caribbean are examples of this phenomenon. In exceptional circumstances, original inhabitants survived; some evolved into different forms, while others remained almost unchanged. Additional plants and animals arrived by air, ocean current or clinging to masses of vegetation or floating logs, perhaps every thousand years. Few of these survived, but occasionally these new colonists were able to adapt to the new environment and thrive. Other islands were formed by volcanic eruptions or coral reefs growing atop extinct volcanoes. Virtually all native fauna and flora of these islands, which include the Hawaiian, Mascarene and Galapagos Islands, were colonizers. The majority of extinct island species were flightless

birds, tortoises and other species unable to flee when European ships and their crews arrived in search of commodities such as spices, timber and fur animals. They were killed for food and sometimes found their habitats destroyed by logging or the many species of animals brought to the islands. They were successful species in adapting to their environment and surviving for long periods, even radiating into entire new families of animals, but nothing had prepared them for the drastic changes humans caused, or the high mortality from hunting or persecution.

Sixty-two mammals, birds, reptiles and amphibians, as well as all but one of 81 species of fish, were native to mainland areas. The continent with the largest number of non-fish extinctions is Australia, with 24 species, 22 of which were mammals, killed off by introduced animals and loss of habitat (see Mammals section in the table: fiThe Geography of Extinctionfl). Non-native species caused the extinctions of many fish in the United States, Mexico and Africa. Killing by persecution or commercial purposes, such as for furs, meat or sport, caused extinctions in Africa, North America, Australia, Europe and Asia. Capture for pets and killing eliminated birds in the Caribbean, Australia and South America. The clearing of forests eliminated a number of tropical birds in Asia and South America. Elimination of wetland habitats was the major cause of the extinction of amphibians and fish, especially those that were ecologically isolated, such as cave fish or desert spring species.

Extinct Species of Birds, Mammals, Reptiles and Amphibians
1500 to present

100-Year Periods	Mammals	Birds	Reptiles	Amphibians	Total
1500-1599	0	6	0	0	6
1600-1699	14	15	3	0	32
1700-1799	13	26	3	0	42
1800-1899	31	56	10	0	97
1900-2000	42	54	12	6	114
TOTALS	100	157	28	6	291

Source: List of Extinct Species in the Appendix of this book.

Fish Extinctions

The *2000 IUCN Red List* lists a total of 81 species of fish that have become extinct over the past 400 years. In addition, a large number of fish have been extinguished in Central and South American lakes Œ scientists are still compiling information. About 20 percent of the world's freshwater fish are indeed either extinct or in steep decline (Wilson 1992).

No version of the *IUCN Red List* has listed many species reported as apparently extinct by biologists around the world. In peninsular Malaysia, where 266 freshwater species were known to exist, a search found only 122 (Wilson 1992). In the Philippines, where massive environmental destruction has taken place, Lake Lanao on Mindanao is famous for its diversity of endemic cyprinid fish. Yet out of 18 species of three genera, an investigation found only three species of one genus (Wilson 1992). These extinctions were apparently caused by overfishing and competition

from introduced species (Wilson 1992).

During this century, several mass extinctions of endemic fish have taken place when the creatures™ sole habitat was destroyed. Lakes in East Africa, the Americas and Russia have either been drained Œ as in the Russia™s Aral Sea Œ or native species have been crowded out or preyed upon by introduced exotic fish.

Africa's Great Rift Valley, a product of movement in the Earth's crust eons ago, is home to several lakes of great biological diversity. Lake Tanganyika has more than 140 endemic species of fish, Lake Victoria has more than 200 and Lake Malawi has at least 500 (McNeeley *et al*. 1990). These three lakes, home to hundreds of members of the colorful cichlid family, rank three, two and one respectively in the world for their diversity of fish (Myers 1979). The lakes have been separated for millions of years, and although Lake Malawi and Lake Tanganyika are only 320 kilometers apart, they have not a single cichlid fish species in common (Myers 1979). Each of these three lakes empties into great rivers; Lake Tanganyika flows into the Zaire, Lake Victoria into the Nile and Lake Malawi into the Zambezi (Kingdon 1989). Most ancient is Lake Tanganyika, 3 to 6 million-years-old and twice the age of Lake Malawi, which is half as old as Lake Victoria (Kingdon 1989). Lake Tanganyika is the second deepest lake in the world at 1,500 meters; only Siberia's Lake Baikal is deeper (Kingdon 1989).

Lake Victoria is a shallow, enormous lake, covering an area the size of Ireland or the state of Maine (Kingdon 1989). Evolution of cichlid fish in these lakes over the ages produced an extremely rich fauna. From a few ancestor species, these fish flourished into an extraordinary diversity, each species filling a different ecological niche. Their diets are extremely varied and may include plankton, crustaceans, mollusks or fish eggs (larvae) and even other fish (Kingdon 1989). Cichlids brood their eggs in their mouths Œ up to a thousand at a time Œ protecting them from their many natural enemies. They exhibit a great range in color, including silver, sapphire and turquoise blue, orange and yellow, and they are patterned in stripes, bars, dots or circles. Resembling the fish one might see in a coral reef, many are popular in home aquariums (Kingdon 1989). Various kinds of tilapia, which are also cichlids, form a major part of the diet of Africans living around these lakes, and they are being raised in aquaculture projects around the world.

These beautiful fish and their ancient ecosystems are now disappearing. The major cause is the Nile perch (*Lates niloticus*), Africa's largest freshwater fish, at more than 6 feet in length. Since 1960, the Uganda Game and Fisheries Department has introduced thousands of these fish as a food source for the local people, despite objections from the East African Fisheries Research Organization (Simon 1995). Even as a food fish, the Nile perch is not rated highly by the local Africans, who prefer the smaller tilapia, which they preserve by drying in the sun (Simon 1995). The flesh of the Nile perch is so oily that it must be smoked, and more and more trees must be cut down for this purpose (Simon 1995). An ecological disaster occurred after its introduction; although intended to increase the lake's productivity of fish, the opposite happened. Gradually, this predatory fish became the dominant species in the lake, and completely destroyed the endemic cichlid fish fauna and fishery (Simon 1995). Of the more than 300 varieties of *Haplochromis* genus cichlid fish (including subspecies) endemic to Lake Victoria, almost two-thirds died out, and the rest became endangered (Simon 1995). Fifty known extinctions have beset Lake Victoria's endemic cichlids. One species, *Haplochromis pyrrhocephalus*, has become extinct in the lake Œ it exists only as a captive colony in the Horniman Museum in London (Simon 1995). Extinctions of the surviving cichlids continue because of predation by the Nile perch and siltation of the lake from erosion of farmland soil on its shores. This prevents these fish from mating because they are not able to recognize the brilliant colors and patterns of their potential mates (Yoon 1997).

The introduction of exotic fish threatens many freshwater species, and overfishing is virtually eliminating a large number of saltwater species. Research on the latter is lacking, but it is likely that many of the 156 species listed as ficriticalfl in the *2000 IUCN Red List* will be listed as extinct in the near future.

Amphibian Extinctions

Six species of amphibians Œ all frogs Œ are known to have become extinct since 1500. No recorded amphibian extinctions have taken place on islands, despite the large number of endemic amphibians native to large islands such as Madagascar, New Zealand, Cuba and Puerto Rico. Many of these, however, now face this threat. Yet it is likely that amphibian extinctions occurred as a result of the draining of wetlands or due to their use in growing rice following the colonization of the latter islands by native peoples thousands of years ago. The extinct frogs were mainland species, and all disappeared during the 20th century. The Israel painted frog (*Discoglossus nigriventer*) became extinct around 1940, when Lake Huleh, its sole habitat, was drained for agriculture. The Vegas Valley leopard frog (*Rana fisheri*) disappeared in 1960 when its desert spring habitat was destroyed by groundwater pumping for agriculture. Two Mexican frogs endemic to wetlands north of Mexico City died out by 1979 after their wetlands were drained for the construction of homes. The best known extinction in recent times is that of the beautiful golden toad (*Bufo periglenes*), which is acknowledged by most experts to have disappeared from its rainforest home on a Costa Rican mountain in the late 1980s. This species had been featured in National Geographic Society films and articles, and was also the subject of a research study when it suddenly died out.

A large number of frogs Œ at least 20 species Œ have not been seen for many years, and many may soon be declared extinct. Some of these are among the most unusual examples of evolution on Earth. In a few pristine areas, frogs have mysteriously vanished. An Ecuadorian biologist reported in the 1990s that a dozen species he had been studying in a high altitude meadow disappeared without a trace. Experts are in disagreement over the causes of the vanishing of so many frog species. Many species are believed to be victims of ozone depletion, which increases the amount of ultraviolet radiation reaching the Earth, destroying frog eggs and often adult frogs as well. Other scientists believe frogs are disappearing from a combination of causes, including disease possibly induced by an immune system lowered by pollutants, pesticides and habitat destruction.

Reptile Extinctions

All but one reptile extinction have occurred on islands. At least 28 island reptiles have died out since 1600. A large number of reptile extinctions took place in the Mascarene Islands, a group of islands in the Indian Ocean, east of Madagascar (see Appendix for more on Mascarene Island extinctions). Thousands of large tortoises were slaughtered for food by European settlers and visiting ships' crews during the 17th century. All three Mascarene Islands and most of their satellite islets were densely populated by various species of tortoises. Each island had species with differently shaped shells: domed for feeding on low vegetation, and high•fronted for other vegetation (Day 1981).

Francois Leguat described Rodrigues' tortoises in the early 18th century: "There are such plenty of Land•Turtles on this Isle that sometimes you see 2,000 to 3,000 of them in a Flock; so that you can go above a hundred paces on their backs without setting foot on the ground. They meet together in the evening in shady places and lie so close that one would think those spots were paved with them" (Day 1981). The large tortoises must have numbered in the hundreds of thousands, judging from the quantity taken by ships to provision their crews and to trade for commodities. Each weighed about 100 pounds, and naval ships vied with one another for rights to them. The tortoises were plundered indiscriminately. Far more were killed than needed by crews and passengers (Durrell 1977). One expert estimated that at least 10 thousand tortoises were taken per year from Rodrigues island alone. Many died en route, as in the case of one shipment of December 6, 1761, in which the ship fiL'Oiseaufl arrived with a cargo of only 3,800 tortoises still living out of the 5,000 shipped (Durrell 1977). The Mauritian tortoises were extinct by 1700,

the two Reunion species by 1773, and the Rodrigues species in 1800 (Day 1981). The last of the tortoises were killed off by pigs consuming the young tortoises and rooting up their eggs in the sand (Day 1981). Eight tortoise species, including three giant tortoises, became extinct (see Table "Extinct Wildlife of the Mascarene Islands").

In all, 13 Mascarene reptile species disappeared forever. The blind cave snake and three skinks or geckoes also disappeared. The most recent extinction was the Round Island Boa, which inhabited an islet off the coast of Mauritius. Livestock and rabbits stripped the vegetation, which caused the extinction of this snake by 1975. No native tortoises or turtles still exist on the Mascarenes. The remaining species of boa and the four gecko and skink species are highly threatened, according to the *2000 IUCN Red List.*

Elsewhere in the world, reptiles have been eliminated mainly as a result of the combined effects of non-native species, such as rats, cats and mongooses. Predators prey and compete for habitat and vegetation, livestock overgraze and settlers destroy habitats. Nine species of iguanas and snakes of the Caribbean became extinct after introduced species of mongoose and rats demolished them. The iguanas were also hunted heavily for food by local people. A number of iguana species barely survive on various Caribbean islands, having become restricted to tiny islets off the main islands where rats, cats and livestock are not present. Four Caribbean reptiles have disappeared. A lizard (*Ameiva major*) and a snake (*Dromicus cursor*) were native to Martinique and became extinct in 1960 and 1962 respectively; the other two were native to Jamaica. A tree snake (*Alsophis ater*) was probably eliminated by forest destruction and predation by the introduced mongoose. The Jamaican iguana (*Cyclura collei*), thought to be extinct, was recently rediscovered, but the species is still highly endangered. The single reptile extinction on a mainland area was a South African lizard, Eastwood's longtailed seps (*Tetradactylus eastwoodae*) Œ it disappeared in 1913.

Bird Extinctions

A bleak picture has emerged, showing a dramatic rise in the rate of bird extinctions over the past 200 years. At least 157 species of birds have become extinct since 1500, and many more have not been seen in decades. In pre-history, approximately one bird disappeared each century (Leakey and Lewin 1995), but the present rate is many times that. During the 17th century, 15 birds disappeared, increasing to 26 birds in the 18th century (at an average rate of about one bird every four years); this was 26 times the pre-history rate. Nineteenth century extinctions totaled 56 bird species, or about a bird every other year. Data for the 20th century is still being totaled, but 54 birds have already been declared extinct since 1900 Œ already almost as many as the entire 19th century™s toll. Thus, the rate of avian extinctions has likely more tripled since the 18th century. A large number of birds have not been seen in the wild for many decades and will likely soon be declared extinct; a period up to 50 years between the last sighting and formal declaration of a species' extinction is generally accorded, unless thorough surveys verify the species is indeed gone.

An important dimension of these extinctions is the fact that birds are considered indicators of the planet's health. Birds are sensitive to environmental pollution, habitat loss and other signs of deterioration, as illustrated when canaries were used by coal miners to test for the presence of lethal methane gas. Their extinctions will also affect the ecosystems in which they once lived, since many birds pollinate plants or disperse seeds, and without them, these plants die off. The story of the dodo (*Raphus cucullatus*) is an example of such a relationship.

Some of the most amazing and unusual species that ever lived are among the birds that have become extinct since 1600. Many of these extraordinary birds evolved on remote islands without human inhabitants over periods of millions of years. The heaviest bird ever to have lived on Earth was the Great elephant bird (*Aepyornis maximus*) of Madagascar, the last of many related species of elephant birds. Some experts maintain this giant bird disappeared prior to 1500 (Brooks 2000), but observers spoke of its continued presence on the island after 1600. The giant moas

of New Zealand are thought by some to have persisted until the 19th century, while others believe they died out a thousand years ago, within a few centuries after the arrival of the Maori people. The brawny great moa (*Didornis torosus*) of New Zealand was perhaps the last of many species of moas, the largest of which was the tallest known bird, some 12 feet in height. It was hunted to extinction like its relatives. Some said it persisted until 1670. Another extraordinary New Zealand bird was unique in that males and females had beaks that were completely different in both size and shape: the colorful huia (*Heteralocha acutirostris*) became extinct early in the 20th century, mainly from the effects of forest destruction and hunting for its feathers, which were sold in the European markets for ladies' hats.

The Mascarene Islands, which remained uninhabited by humans until the 17th century, once had an unparalleled diversity of birds, including an array of many odd flightless birds such as the famous dodo. Flightless herons and storks fished in the streams, and enormous parrots Œ their beaks as large as their heads Œ lumbered about in search of fruits and seeds. Each island had its own distinctive parrot species. Some of the native parrots had not become flightless, and each of the seven or so species occupied its own ecological niche. Gray parrots with bright red beaks, small gray parakeets and two types of lime green parrots with very long tails swooped about in large flocks (Fuller 1987).

Large numbers of the flightless, turkey•sized dodos waddled about on Mauritius. The birds, weighing about 50 pounds and covered with grayish, downy feathers, fed on hard-shelled seeds. Of all birds that have become extinct, this species is perhaps the most famous. The dodo™s common name apparently came from fidodoor,fl a Dutch word meaning sluggard, and dodaers, a lubber, or awkward sailor (Halliday 1978). The creature's original scientific name was *Didus ineptus*, indicating its inability to flee humans or defend itself.

In fact, the dodo was the final result of thousands Š perhaps millions Š of years of evolution in isolation on an island with no land predators. Wild pigeons of an unknown species landed by chance on Mauritius at some early date and became resident, gradually evolving into a gigantic form of the original immigrant. The dodo may have evolved from New Guinea and Pacific Islands tooth•billed pigeons that landed in the Mascarenes, according to some zoologists (Halliday 1978). Tooth-billed pigeons also have curious hooked beaks, although the dodo's 9 inch beak was far more massive. Yet whatever its ancestry, the dodo became flightless in its predator•free environment. Its feathers lost their sheen and aerodynamic quality and came to resemble the down of nestling birds.

Mauritius was first visited in the early 16th century by Portuguese sailors, and was later settled by the Dutch, who brought pigs, goats and cattle. These domestic animals soon multiplied and overran the islands. Pigs rooted in forests, devouring rare flora, and cattle and goats overran the fragile tropical vegetation. Rats swam from ships and colonized the main islands; they preyed on flightless birds, eating their eggs and young, even climbing trees to devour nesting songbirds. Mongooses native to Asia were brought to Mauritius, which presented a lethal threat to native birds and other wildlife. Long-tailed macaques (*Macaca fascicularis*) were imported as pets at some point from Southeast Asia and then released into the forests of Mauritius, spreading throughout the island and preying on native birds. Settlers also cut the trees needed by native birds for habitat and food. The delicate plants, forests and vulnerable wildlife were devastated by this onslaught.

Portuguese and then Dutch seamen and colonists slaughtered thousands of dodos, using them as a major source of food. They cut down the seed-bearing trees dodos fed upon, and their eggs and chicks may have been preyed on by rats and introduced macaques (Fuller 1987). Settlement began in 1634, and within less than 30 years, the once-common dodos were slaughtered to extinction. The settlements failed and Mauritius remained uninhabited for a period of time.

The last account of wild dodos dates from 1662. A Dutchman named Volquard Iversen was deserted on Mauritius soon after both the early settlement and the penal colony failed (Quammen 1996). Iversen and his shipmates scoured the island for food and found no dodos, but they did see some on a small islet off the coast. He described them as "larger than geese but not able to fly. Instead of wings they had small flaps; but they could run very fast" (Quammen 1996). The islet protected the last few dodos from human hunters and introduced predators, and until then, the tiny

population had remained undetected. Iversen's party waded through the shallow water to the islet and captured a dodo. "When we held one by the leg he let out a cry, others came running forward to help the prisoner, and they were themselves caught" (Quammen 1996). These were the last of their species. Altruism, a trait that has helped many animals survive through mutual aid, has also caused extinctions. Human hunters have taken advantage of this, killing animals that come to the aid of each other.

In the centuries since its demise, the dodo has come to symbolize extinction, but many still think of this bird as stupid, giving rise to the expression "dumb as a dodo." Animals are frequently deemed stupid if their natural defenses against humans are inadequate, or vicious if they are able to defend themselves. Yet this bird so many people have described with disdain came to the rescue of its fellows, even at the risk of its own life, and was an extremely successful species within its environment. If the word dodo must be seen symbolically, then it would be more reasonable to equate it with human stupidity, because our own species wantonly destroyed this extraordinary bird. In the opinion of Errol Fuller (1987), author of the authoritative book *Extinct Birds*, "The dodo was one of the most fantastic creatures ever to have lived."

In 1973, Dr. Stanley Temple, an ornithologist, made a remarkable discovery about the dodo. He noticed that a beautiful tree native to the island, the calvaria or tambalacoque tree, was reduced to 13 dying specimens, all more than 300 years old. Gerald Durrell (1977) described these trees as at least 50 feet tall, with massive crowns and silvery, gnarled trunks; cracks appeared in their buttress roots. Since no young trees were located, it occurred to Dr. Temple that no seeds had germinated since the 17th century when the dodo became extinct. Apparently, stones found in the dodo™s gizzard by sailors butchering it for food might have been able to abrade the thick shell covering the seeds. Dr. Temple fed some of the seeds to domestic turkeys, which were presumed to have similar digestive systems, and of 10 seeds recovered from feces or regurgitation, three sprouted when planted (Anon. 1978).

Some scientists now believe this tree could germinate without the dodo. A surviving parakeet is thought to be able to crack its hard-pitted seeds, and the extinct Mauritius flying fox and some of the extinct parrots were able to do so as well(Quammen 1996). Dr. Wendy Strahm, in her botanical work on Mauritius, has found young trees of this species that germinated in the past 300 years, although they are quite rare (Quammen 1996). Another scientist, Anthony S. Cheke, believes seed germination has continued, but at a low rate Œ perhaps too low to maintain the species long-term. The rarity of the tambalacoque tree was considered to be due to seed predation by rats, deer browsing on saplings, rooting by pigs and perhaps browsing by the introduced macaque monkeys (Quammen 1996). Yet dodos were likely major seed distributors of this tree in the pre-human environment, and their role has not been successfully replaced ecologically. The introduction of a veritable zoo of non-indigenous species has reaped havoc on a variety of native plants.

The dodo's close relatives on neighboring islands are far less known. On Reunion, a bird called the Reunion solitaire (*Raphus solitarius*) was described by early visitors to the island as resembling the Mauritius dodo, except its beak was somewhat smaller, its plumage was white and the tips of the wings and the tail were black (Fuller 1987). One traveler, M. Carre, said in 1699: "The beauty of its plumage is a delight to see. It is of changeable color which verges upon yellow" (Fuller 1987). Two were taken aboard ship as a present to the French king, but both refused to drink or eat and soon died. M. Carre noted in his description that "The flesh is exquisite; it forms one of the best dishes in this country, and might form a dainty at our tables" (Fuller 1987). This was an ominous prediction of its final fate. The Reunion solitaire probably died out about 1715 as a result of being slaughtered for food.

On tiny Rodrigues, yet another dodo-like bird existed. Far more is known of this species, whose bones have been found in caves on the island. Its beak was shorter and its neck was longer, but it also apparently evolved from pigeon ancestors (Halliday 1978). It was called the Rodrigues solitaire or solitary (*Pezophaps solitaria*) for its habit of feeding alone on leaves and fruit in secluded places. Errol Fuller's description in *Extinct Birds* evokes its once peaceful existence: "In this tranquil kingdom generations of solitarys must have lived enjoying extraordinary peace and seclusion until their world was shattered by the coming of man."

Francois Leguat, a Huguenot refugee, left extensive descriptions of these birds when he spent two years on Rodrigues after he was marooned there with a small group of followers in 1691 (Fuller 1987). "They walk with such stately form and good grace," Leguat wrote, "that one cannot help admiring and loving them" (Fuller 1987). He watched them nesting and feeding their chicks until they fledged at several months. The male and female defended their territory, driving other solitaires away with a dramatic display in which a bird pirouetted for four to five minutes while whirring its wings violently to produce a loud rattling noise that could be heard 200 yards away (Halliday 1978). If this impressive display did not frighten other birds away, they used knobby growths at the joints of their flightless wings in combat with other solitaires (Halliday 1978). Some wing bones now found in museums have healed fractures, an indication of the violence of these encounters (Halliday 1978).

Leguat saw the parents of solitaires escorting their single chick to a gathering of some 30 other solitaire families, where the adults would leave the chicks. Tim Halliday wrote in *Vanishing Birds* (1978) that he believes what Leguat witnessed was actually a sort of nursery gathering, similar to that which flamingos and some penguins organize while adults go off to feed. Although these birds were able to hide in foliage and could run quickly, hunters chased them down and butchered every last bird. People slaughtering them found stones in their gizzards Œ even in those of very young nestlings. How they got there remains a mystery, since the stones were too large to have passed down the gullet (Halliday 1978). The last solitaire was seen around 1746, and the species was deemed extinct by the 1760s (Brooks 2000).

The origin and affinities of these three species of pigeon-like birds in the Mascarene Islands will be disputed by scientists for some time to come. Tim Halliday (1978) conjectured that the dodo may have evolved from a pigeon, such as the tooth-billed pigeon (*Didunculus strigirostris*) of the Pacific Œwhich has a similar but far smaller hooked bill Œ or that they were related to rails. It is also possible the dodo had one ancestor and the solitaires had another. What is not disputed is that they left no close relatives. No living birds on Earth are related to the dodo and the solitaire, or bear any strong resemblance to them.

Other flightless native birds of the Mascarenes disappeared as well: all the huge parrots, three kinds of owls, three rails, several small pigeons, two night herons, a stork and an ibis. Little is known about many of these birds, but two of the rails were described in detail. The Rodrigues or Leguat's rail (*Aphanapteryx leguati*) had bright gray plumage flecked with white and gray, a curved red bill, red legs and feet and a red ring surrounding the eye (Taylor 1998). The bird™s call consisted of a long whistle, but when pursued, the rail gave an alarm call that sounded like a person with a hiccup (Taylor 1998). This species fed on tortoise eggs and, like the related Mauritian red rail (*Aphanapteryx bonasia*), could be lured by holding out a red object and trapped when the bird came to attack the lure (Taylor 1998). They were described as delicious, and were killed to the last bird. Among flighted species lost were a type of weaver, a starling and a falcon (Brooks 2000; Fuller 1987; Greenway 1967). The total of 31 extinct birds is more than that of any other island group or continent.

However extraordinary such a toll may seem for a group of small islands, it may represent only a percentage of Mascarene avian extinctions. Stanley Temple estimated that prior to the arrival of humans, 68 species of birds lived on the three main islands and, of these, 45 species (66 percent) became extinct after 1600 (Temple 1981). The 14 species not officially included among the extinct birds of these islands were described by travelers but have not yet been authenticated. The majority lived on Mauritius. Future archeologists are certain to discover far more about the birdlife that once inhabited these islands, and genetic studies of specimens from which DNA can be extracted may help identify their origins.

The Hawaiian Islands vie with the Mascarenes for numbers of extinctions. At least 21 species and many more subspecies have become extinct since 1600. One of these was native to the remote swamps of Kauai. The Kauai Oo (*Moho braccatus*) had pitch black plumage brightened by several long, canary yellow feathers. The male had a haunting, fluted call. The species dwindled as forests were cut, and by 1960, only 12 birds were known to remain. A single pair survived by the 1980s. The female disappeared after a hurricane in 1985 (Brooks 2000), and the male lived on a few more years as the last member of his species. He was seen singing and building a nest with each final

year, trying to attract a mate who never came (Daws 1993). He was last seen in 1987 (Brooks 2000).

The Kauai Oo was the last of a group of dramatic songbirds that once lived on all the major islands. The Hawaiian honeycreepers found only here evolved from one or a small number of ancestor species Œ likely a New World finch, warbler or honeyeater Œ into an estimated 40 to 50 brilliantly colored birds, before the arrival of the Hawaiian people. Some species were probably eliminated after they were killed in tremendous numbers for their feathers, then made into elaborate headdresses and cloaks for Hawaiian royalty, but the major cause of their extinction was the destruction of their forests by European settlers. As the honeycreepers retreated to smaller and smaller habitats, often surrounded by ranchland, sugar cane and pineapple farms, their habitats and food trees disappeared. Their fragmented populations were susceptible to avian malaria, which spread throughout the islands in the 20th century, brought by exotic cage birds that had escaped or been released by their owners. Thousands of birds died of the disease. The extinction toll of native birds within the past few hundred years stands at 21 species, in addition to even more subspecies. Twenty-three honeycreepers survive, but most are so endangered they are not expected to survive more than a few more decades. One critically endangered honeycreeper, the po'o-uli (*Melamprosops phaeosoma*), has a total population of three birds: two males and one female live in a reserve and the adjacent Haleakala National Park on Maui (BI 2000). This small, masked brown-and-white bird, discovered in 1973 by a graduate student, once numbered 200 individuals before it underwent a drastic decline between 1975 and 1985 as a result of avian malaria and habitat destruction by feral pigs within its reserve (BI 2000). All three birds live in separate home ranges, and the species has little chance of survival.

Rails are the most characteristic of all island land birds. These compact and stocky creatures are most frequently seen in wetland habitats, but some live in forests or grasslands. Almost all islands in tropical latitudes have or had endemic rails or fossil evidence of their past presence. Larger islands have several native rails, and it has been estimated that as many as 2,000 flightless rails inhabited Polynesian and western Pacific islands alone, prior to their colonization or visits by humans who exterminated them. Many of these instances were in prehistoric times by Maori, Hawaiians and other native peoples (Taylor 1998). Some 23 species of island rails, virtually all flightless, have been exterminated since 1500 Š far more than any other avian family (see Appendix).

Rails are not likely candidates for colonizing islands because they are, in the words of S. Dillon Ripley (1977), an authority on rails, "loath to fly." When frightened, they usually do not take wing, but disappear into matted vegetation. When they do fly for short distances, it is rather feebly, and their legs dangle down. How could they have reached islands thousands of miles from the mainland? Some rails are long-distance migrants, while other species disperse in erratic patterns (Taylor 1998). Rails tend to travel in groups at night and are often blown off course. European rails on their way to Africa have ended up far from their wintering site (Taylor 1998). European Corncrakes, for example, have landed, exhausted, on ships in the Indian Ocean or even off New Zealand (Ripley 1977). North American Purple Gallinules, colorful rails of southern marshes, have flown to tiny Tristan da Cunha island halfway between South America and Africa in the South Atlantic (Ripley 1977). The Common Moorhen (*Gallinula chloropus*) of Eurasia, North and South America and Africa has colonized St. Helena, the Azores, the Seychelles, the Marianas and Hawaii, among other islands. These colonizing rails usually become flightless if they have are no enemies, such as native predators. Some become the size of large chickens. Once flightless, however, they are vulnerable to predation by animals brought by humans.

The Laysan rail or crake (*Porzana palmeri*) was driven to extinction by imported rabbits who rendered Laysan Island devegetated. Biologists transported it to nearby Midway Island, where it flourished until World War II, when the island became a naval base. The navy personnel were entranced by this utterly fearless and agile bird that sprung into people's laps or onto the mess table in search of crumbs of food. Unfortunately, the species perished soon after 1942, when rats from a naval landing craft apparently ate the rail's eggs and preyed on its young. A few of the rails had been returned to Laysan Island after rabbits were removed, but the vegetation had not recovered sufficiently and the birds did not survive (Ripley 1977). Most other island rails have died out from similar causes.

Since about one-third of the world's birds are endemic to islands, and they have been reduced by 30 to 50 percent

since humans came to these islands. Their extinctions represent a true biological catastrophe, in the words of Storrs Olson, an authority on extinct birds (Taylor 1998). The vast majority of avian extinctions in the past 500 years have been island birds Œ victims of predation, competition from introduced animals and disease from cagebirds. Many were also killed for food or trade. Non-indigenous species are still causing bird extinctions on islands. In all, 137 of the 157 bird extinctions (87 percent) since 1500 have been island species, and human activities and animals introduced by humans have been responsible. Island species have been more vulnerable to extinction than mainland species because of their small populations and limited habitats. Many were flightless or slow-moving species, unable to flee predators, including humans. Some were specialized in their diet and habitat and could not adapt to changes made in their environment.

Mammal Extinctions

Cuba, Puerto Rico, Hispaniola and Jamaica had a variety of unusual native rodents and shrew-like insectivores prior to the arrival of European explorers and settlers in the 1600s; many were ancient species. When native Caribbean populations settled the islands after the Ice Ages, rodents as big as marmots inhabited the larger islands. A type of giant sloth lived in Puerto Rico, and a rodent nearly the size of the American black bear inhabited the small islands of Anguilla and St. Martin until it was apparently hunted to extinction by natives (Olson 1978). Cuba, Puerto Rico and Hispaniola were once attached to the mainland of Central America, but this large land mass became separated and drifted off into the Caribbean. Some of the native fauna and flora present more than a million years ago survived until a few thousand years ago, and tiny frogs and butterflies from that period persist today.

When Europeans colonized the Caribbean islands, they began cutting forests and replacing them with huge plantations of sugar cane, other crops and grazing land for livestock. They imported thousands of slaves to farm the land. Mongooses were brought on the islands to control snakes, but they preyed on native mammals and birds instead; rats arrived in ship holds and did the same. Fifteen mammals have become extinct on Hispaniola, the island divided between present day Haiti and the Dominican Republic Œ this island suffered the highest number of mammal extinctions of any Caribbean island. Forests have been nearly obliterated on Haiti, which is another cause of extinctions. Cuba, Puerto Rico and Jamaica have likewise lost the majority of their forest cover, as well as many native mammals, including bats, rodents and insectivores. Jamaica was home to a monkey (*Xenothrix mcgregori*), making it the only Caribbean island with a native primate. It was hunted and its forest habitat was cut by European colonists, and it died out in the 1750s. Various species of hutias, large rodents found on most major islands, became extinct as well. Hutias remain on a few Caribbean islands but are close to extinction from forest destruction and predation by introduced mammals.

Most of the 40 mammals that became extinct on Caribbean islands after 1600 were rodents and insectivores. A muskrat and a rice rat became extinct on Martinique when Mt. Pelee erupted in 1902 Œ one of the few examples of a naturally caused modern extinction. Hutias, large rodents that resemble South American agoutis, proliferated into a variety of species on the large islands of the Greater Antilles. Settlement, deforestation and hunting caused at least five species of hutias to become extinct, and the few remaining species are now highly endangered.

The first mammal to disappear after 1600 was a massive wild cow called an auroch (*Bos primagenius*). This species, native to most of Europe, lived in the deciduous forests that once covered most of the continent. The auroch

was also hunted for its meat and died out about 1627. Several other wild cattle related to the auroch survive in Southeast Asia, but they are critically endangered. The tarpan (*Equus gmelini*), a wild horse of Europe, gradually became rare and restricted from hunting and destruction of its native forests during the Middle Ages. The last wild tarpans were killed off in 1851 (Day 1981). Both the auroch and the tarpan are depicted by Pleistocene humans in magnificent cave paintings found in southern Spain and France.

The Steller's sea cow (*Hydrodamalis stelleri*) was an enormous 24 to 30 feet long marine mammal, similar in appearance to the dugong and the manatee. The sea cow was larger, however, and swam in the cold arctic waters of the Bering Sea, enduring temperatures that would kill its closest relatives. The slow and sluggish sea cows were killed off only 27 years after their discovery. They were first seen by the shipwrecked crew of the explorer Vitus Bering in 1741 in the vicinity of Bering Island in the Commander Islands, off the eastern coast of Russia's Kamchatka Peninsula. These sea cows were tame and easy to spear and harpoon by the ship crews who killed most of the population, calculated at only about 1,500. This animal showed extreme protectiveness toward its fellows and strong bonds between mates. The naturalist Georg Wilhelm Steller, after whom the species was named, described their behavior on being harpooned.

. . . Some of them tried to upset the boat [when another sea cow was struck] with their backs, while others pressed down the rope and endeavored to break it, or strove to remove the hook from the wound in the back by blows of their tail, in which they actually succeeded several times. It is most remarkable proof of their conjugal affection that the male, after having tried with all his might, although in vain, to free the female caught by the hook, and in spite of the beating we gave him, nevertheless followed her to the shore, and that several times, even after she was dead, he shot unexpectedly up to her like a speeding arrow. Early next morning, when we came to cut up the meat and bring it to the dugout we found the male by the female, and the same I observed on the third day when I went there by myself for the sole purpose of examining the intestine (Day 1981).

Australia has been the scene of more mammal extinctions than any other continent or island group. Beginning in the 19th century, Australia's mammals disappeared in large numbers. Native marsupials and rodents were gradually eliminated by massive habitat destruction and predation from animals introduced by European settlers. Twenty-two mammals became extinct after 1600. A wide variety of marsupials, from small species to wallabies, was extinguished within a century of settlement. Some, like the thylacine, or Tasmanian wolf (*Thylacinus cyanocephalus*), were deliberately persecuted by livestock ranchers under the misapprehension that the species presented a threat to flocks.

The crescent nailtail wallaby (*Onychogalea lunata*) was native to the gum forests of western Australia where John Gilbert, a 19th century museum collector, found the animal common in thick scrub, "where it is occasionally seen sunning itself" (Strahan 1995). This small marsupial weighed less than 20 pounds and looked like a miniature kangaroo. It rested in hollows in soft ground beneath shrubs during the day, feeding mainly at night on roots and coarse grass (Nowak 1999). When chased, it would run to a hollow tree with a hole in the bottom and clamber up the sides until it got high up within the trunk; aborigines used smoke to chase them out and then killed them for food (Strahan 1995). The aborigines also hunted these animals by building brush fences and enclosures and driving the animals into areas where people waited with clubs (Strahan 1995). In spite of hunting, this wallaby was fairly common until 1900, and many were collected for museums (Strahan 1995). It disappeared from the southern portion of its range early in the century after intensive forest clearance and development of the country for agriculture. Gradually, it became very rare, and disappeared altogether from the wild in the 1960s (Nowak 1999, Strahan 1995). Some experts suggested the removal of the thickets where these wallabies sheltered during the heat of the day left them homeless and vulnerable to predation (Nowak 1999).

Millions of acres of eucalyptus forests and mulga woodlands of southern and western Australia were clearcut by settlers beginning in the 19th century, opening up the land to wildfires (Lines 1991). The devastation of these habitats was described in *Taming the Great South Land. A History of the Conquest of Nature in Australia*, by W.J. Lines (1991). The combination of this habitat destruction, hunting and introduced predators, such as feral dogs, was responsible for the extinction of the Crescent Nailtail wallaby and many other native marsupials.

Various endemic Australian rodents and bats died out as well, and many of the remaining native mammals are become confined to tiny islands off the coasts Œ the only habitats where introduced animals are absent. Australia is like an island in having been isolated from other land masses for millions of years, and the majority of its mammals are endemic to the continent. In fact, it is often referred to as the "Island Continent." If Australian extinctions are included among those on islands, 87 percent of all extinctions of vertebrates other than fish have occurred on islands.

In Asia, the freshwater baiji dolphin species was until recently found throughout the Yangtze River and its surrounding lakes and tributaries. Unfortunately, the exponential growth of the Chinese population posed a variety of threats to its survival. A lack of information, growing threats and the species' small population size eventually led to the baiji's decline, despite protective efforts. Baiji dolphins were last officially sighted in 2004, and a 2006 expedition deemed the species "functionally extinct."

THE GEOGRAPHY OF EXTINCTION (chart)

1600 to present					
	Number of Species Extinct				
Islands	**Birds**	**Mammals**	**Reptiles**	**Amphibians**	**Total**
Atlantic Islands					
Ascension I.	1				1
Canary Is.	1		1		2
Cape Verde Is.			1		1
Falkland Islands		1			1
Gull Island (Off NY, USA)		1			1
Iceland, Funt I. (Canada)	1				1
St. Helena	7				7
Subtotals	10	2	2		14
Caribbean					
Barbuda		2			2
Barbados		1			1

Bahamas	1				1
Caribbean region	2	1			3
Cayman Is.	1	1			2
Cuba	1	7			8
Guadeloupe	2		1		3
Hispaniola (Haiti & Domnican Republic)	1	15			16
Jamaica	4	2	2		8
Martinique	1	2	3		6
Navassa I.			1		1
Puerto Rico		6			6
St Croix (Virgin Is.)			1		1
St Lucia		2	1		3
St Vincent		1			1
Subtotals	13	40	9		62
Indian Ocean Islands					
Amsterdam Island	1				1
Christmas Island		3			3
Madagascar	2	1			3
Mascarene Is.	31	1	13		45
Seychelles	2		1		3
Subtotals	36	5	14		55
Mediterranean					
Sardinia		1			1
Subtotal		1			1
Pacific Islands					
Auckland I.	1				1
Bering I. region	1	1			2
Bonin Is.	3	1			4
Caroline Is.	3				3
Chatham Is.	5				5
Fiji Is.			1		1
Galapagos Is.		7			7
Guadalupe I.	2				2
Guam	1	1			2
Hawaiian Is.	21				21
Lord Howe & Norfolk Is.	6				6

Kangaroo I. (Australia)	1				1
Marquesas	1				1
New Caledonia	4				4
New Zealand	14	1	1		16
Okinawa		1			1
Pacific region	1				1
Palau		1			1
Philippines		3			3
Ryukyu Is.	1				1
Samoan Is.	1				1
Santa Cruz Is.		1			1
Society Is.	7				7
Solomon Is.	1				1
Tonga Is.	1				1
Vanuatu	1				1
Wake I.	1				1
Subtotal	77	17	2		96
Asia					
Indonesia	1				1
Subtotal	1				1
Island Totals	137	65	27		229
Mainlands					
Africa		5	1		6
Asia	2	1			3
Australia	2	22			24
Europe & Near East		2		1	3
Mexico & Central America	3	4		4	11
North America	3	1		1	5
South America	10				10
Mainland Totals	20	35	1	6	62

Source: Table of Extinct Species in the Appendix of this book. Sources of information are listed with the table.

Note: See the Appendix for the list of these species in chronological order, and the references that describe these animals and their extinctions, as well as those that include illustrations of the extinct species.

The following account chronicles some of the many extinctions and destructions of natural ecosystems that have taken place in North America over the past few hundred years. Great biological treasures have been stolen from future generations, and the processes by which they were lost are typical of those occurring elsewhere in the world. The

sudden loss of the most abundant and prominent wildlife species of the continent created a profound shock in the public early in the century that set the stage for today's conservation and humane programs. This concern may turn the tide for species that could suffer the fate of the passenger pigeon (*Ectopistes migratorius*) and others, but unless public opinion is better translated into public policy regarding the land and wildlife, further losses will occur and the lessons that might have been learned will be ignored. A strong and pragmatic commitment to preserve what remains of the natural world on the continent, based on a realization that our fate is linked to nature's fate, is essential to prevent further extinctions.

Epitaphs for North America's Lost Species and Environments

After the loss of the majority of large Pleistocene mammals, native peoples in North America became conservationists of the remaining wildlife and the continent's environment. Many tribal religions deified animals and believed they embodied the spirits of their people. They hunted and fished on a subsistence basis. This resulted in relatively few animal extinctions over the tens of thousands of years that passed before settlement by Europeans in the 16th century. The land that awaited new settlers was spectacular in its beauty and abundance of wildlife. Over the next three centuries, however, an unprecedented level of slaughter and drastic environmental alteration destroyed many of these natural treasures.

An Abundance of Wildlife

Early European voyagers landing on the East Coast of North America were astounded to see animals in numbers they had never before witnessed. Fish swarmed in the millions. Captain John Smith came upon vast schools of fish in tributaries of the Potomac River, near the Chesapeake Bay, in 1608: "–in diverse places that abundance of fish lying so thick with their heads above the water [that] as for want of nets (our barge driving among them) we attempted to catch them with a frying pan, but we found it a bad instrument to catch fish with. Neither better fish, more plenty, nor more variety for small fish had any of us ever seen in any place so swimming in the water–" (Hawke 1970). Lobsters were so prolific that one haul of a fisherman's net would bring in more than 100; settlers used them as fertilizer and fish bait. Huge sturgeon 10 feet long swam up major rivers to spawn along the East Coast. Offshore, whales and herds of dolphins migrated along the coasts. The northern right whale (*Eubalaena glacialis*) fed on plankton in shallow lagoons as it migrated to its breeding grounds off Florida. The now-extinct Atlantic gray whale (*Eschrichtius robustus*) was a common marine resident, swimming and feeding offshore. At the present sites of Boston, New York and Philadelphia, vast saltwater marshes surrounded river deltas. Shorebirds and waterfowl darkened the sky with their millions.

Along the craggy rock•strewn coasts of Maine and the Canadian maritime provinces lived a large mink, almost double the size of the American species found elsewhere in the country. Unlike any other type of mink in the world, the animal was a coastal species that soon became known to colonists and fur trappers as the sea mink (*Mustela macrodon*). One sea mink killed in 1867 measured 32.5 inches in length, enormous in comparison to the American mink, which does not exceed 23 inches (Mowat 1981). The sea mink's pelt had twice the value of the inland species in the fur trade (Allen 1942).

An early account by the English naturalist Joseph Banks, who traveled to Newfoundland in 1766 to study the local fauna, described the sea mink as "bigger than a Fox, tho not much, in make and shape nearest compared to an Italian Greyhound, legs long, tail long and tapering" (Mowat 1981). It is unlikely that the sea mink was as long•legged as a greyhound, but available information indicates it was quite different from any closely related species. Bones from the

sea mink have been found along the coast of Maine and New Brunswick (Allen 1942). The fur traders decimated these minks long before scientific or biological studies could be carried out. One early observer described the avid pursuit of sea minks in Maine:

> *Some seventy•five years ago, and for many years thereafter, my father, who was a fur•buyer, used to have nearly all the furs taken on the islands of Penobscot Bay . . . these sea mink used to bring considerably more than others on account of their great size . . . they were persistently hunted . . . with dogs trained for the purpose. As the price of mink rose, they were hunted more and grew scarcer, 'til in the sixties, when mink skins brought eight or ten dollars apiece, parties who made a business of hunting nearly or quite exterminated the race. Some of these men went from island to island, hunting any small ledge where a mink could live. They carried their dogs with them, and besides guns, shovels, pick•axes and crow•bars, took a good supply of pepper and brimstone. If they took refuge in holes or cracks of the ledges, they were usually dislodged by working with shovels and crow•bars, and the dogs caught them when they came out. If they were in the crevices of the rocks where they could not be got at and their eyes could be seen to shine, they were shot and pulled out by means of an iron rod with a screw at the end. If they could not be seen, they were usually driven out by firing in charges of pepper. If this failed, then they were smoked with brimstone, in which case they either came out or were suffocated in their holes. Thus in a short time they were nearly exterminated* (Beard 1947).

The last known sea mink was killed in 1880, and its pelt was sold to a fur buyer in Jonesport, Maine (Mowat 1981). Only fragments of bones and teeth found in excavations of Indian cooking sites attest to its existence (Nowak 1999).

A beautiful North American waterfowl species also disappeared. The male Labrador duck (*Camptorhynchus labradorius*) had striking black•and•white plumage, while the female was mousy brown. During the 19th century, these birds were often seen in fall and winter off New York's Long Island and on the New Jersey coast. Named for the Canadian peninsula where naturalists of the day assumed that they bred, eggs reported to belong to this species had been seen by a naturalist, but the nests were never found (Greenway 1967). This duck had a soft bill, and inside its mouth, lamellae filtered its food. The Labrador duck was assumed to have a specialized diet, possibly of small surface invertebrates that it filtered while dabbling at the surface. The ducks also fed on mollusks, as hunters discovered when they caught them with fishing lines baited with mussels (Fuller 1987).

Labrador ducks were strong flyers who flew in tight, small flocks (Day 1981). Along with virtually all waterfowl of the day, they were shot for the feather and food markets. Gunners killed entire flocks of waterfowl, bringing them to market, where they were heaped in piles. The ducks were killed for no purpose, since they were not sought after as food and considered too "fishy" by most customers. Many of the birds shot by hunters were left to rot, unsold at markets (Day 1981, Greenway 1967). The Labrador duck, first described scientifically in 1789, was always considered rare, and the last known specimen was a bird shot off Long Island 86 years later, during the autumn of 1875. This male is kept in the US National Museum of Natural History (Fuller 1987). The Labrador duck was apparently hunted to extinction, a victim of the totally unrestricted waterfowl hunting that characterized the 19th century, based on its prevalence in game markets (Day 1981).

Further north, a flightless bird walked upright on its flippered feet. At a length of 3 feet, the great auk (*Alca*

impennis) was the size of a large penguin, and could have been mistaken for one. Like many northern seabirds, it had a black back and white belly, but each side of its face was dramatically marked with a large, white oval. Its bill was long and hooked. Great auks were far larger than any of their cousins Œ the murres, puffins and guillemots of the North Atlantic. At one time, these birds ranged along most of the coasts and islands of the North Atlantic, from northern France through Scandinavia, England, Scotland and Iceland, to North America's eastern coast as far south as Martha's Vineyard, Massachusetts (Greenway 1967). Based on fossil evidence, great auks were once as numerous as most other sea birds of the region (Greenway 1967).

The very oldest bones, excavated on the island of Jersey in the English Channel, are between 70 and 90 thousand-years-old (Greenway 1967). As the only flightless bird in the North Atlantic, it was once widespread and numerous. When people approached the birds while they were on land nesting, great auks would immediately waddle to the water's edge and dive in. They were rapid and expert swimmers, using their wings to propel them. When cornered on land, however, they were helpless. Both parents raised the chicks, and they refused to desert their nests, even when attacked. For centuries, hunters took advantage of this trait, pursuing and killing them during their breeding season. Ship crews slaughtered thousands for provisions and took live birds on board for future meals.

Gradually over the centuries, great auks disappeared from most European coastlines and offshore islands as a result of hunting. The last record in the British Isles was on St. Kilda, an island west of northern Scotland, where some local residents captured a Great Auk in 1821; although kept captive with a string attached to its foot, it managed to escape (Fuller 1987). Twenty years later, as recounted by an older resident, another auk was found asleep on a rock on the same island and captured, kept for three days, and then killed because these superstitious people feared that it was a witch (Greenway 1967).

Great auk feathers were harvested in grisly "factories" on Funk Island off Newfoundland in the 18th century. Collectors built pens of piled boulders into which they would drive the hapless great auks from their nests. Once the auks were cornered in the pens, the men would swing spiked clubs at the birds, killing or wounding them (Day 1981). The birds were then thrown over the enclosure walls into piles near the fires; there the dead and wounded birds were dropped into boiling cauldrons or thrown directly on the fires (Day 1981). The boiling water caused the feathers to float to the surface, where they were scooped up and stuffed into bags; the corpses were next dragged down to the water where they were dumped (Day 1981). Some observers, including Captain George Cartwright, an early colonist on Labrador, watched boats coming ashore laden with hundreds of carcasses from Funk Island. He wrote in July 1785, "If a stop is not soon put to that practice, the whole breed will be diminished to almost nothing" (Birkhead 1994). By 1800, all the island's great auks had been killed. The ashes and pens still remain on Funk Island as the only reminder of this extraordinary bird.

Islands off Iceland and Newfoundland became the last refuges of the great auk. When word spread in the 19th century that the species was nearing extinction, hunters went in search of them for museums and egg collections. The eggs and skins of the Garefowl, as it was known to Europeans, were sold at auction in London and to European museums for very high prices. Hundreds of English pounds were offered for each egg, encouraging fishermen to comb islets for the last of the nesting birds. The only remaining birds known to survive were killed on Eldey Island off southwest Iceland on June 2, 1844; three Icelandic fishermen who discovered two birds, a breeding pair with a single egg, strangled the adults and threw them into a boat (Birkhead 1994). These last great auks were killed for their skins, which were sold to a dealer (Birkhead 1994).

Other marine creatures barely avoided extinction during the period of unregulated killing of wildlife that began in the 1600s. The Atlantic walrus (*Odobenus rosmarus rosmarus*) herd off the Canadian coast numbered at least a quarter of a million animals prior to European exploitation. Between 1633 and 1642, vessels from the Massachusetts Bay Colony made a number of expeditions to Sable Island off Nova Scotia to kill the walruses for their tusks and oil. Glover Allen (1942), in *Extinct and Vanishing Mammals of the Western Hemisphere*, chronicles one sealing voyage in 1641 in which 12 men who spent eight months on Sable Island returned with "400 pair of sea horse teeth, which were esteemed and worth 300 pounds." The walrus colonies in the Gulf of St. Lawrence numbered seven or eight thousand

at that time; they were killed off by American sealers, who worked at night while the walruses slept on land (Allen 1942). Gradually, the Atlantic walrus became exterminated in all areas on the continent. From 1925 to 1931, the last large population in the Canadian Arctic on Baffin Island was devastated by the killing of 175 thousand animals (Nowak 1999). Although finally given protection, the species has not shown a substantial recovery because of the high kill by native peoples, which equals annual recruitment in the western Atlantic (Nowak 1999). Only 25 thousand walruses remain in this region. Russia classifies the species as vulnerable and the population in the Laptev Sea as rare (Nowak 1999). They may have increased somewhat along the coast of Norway, in the Svalbard region and Barents Sea (Nowak 1999).

Although the Pacific gray whale has now recovered from near•extinction from whaling, few people are aware that this species once lived in the Atlantic as well (Allen 1942, Mowat 1981). Large numbers of Atlantic gray whales migrated along North America's eastern coast until as late as the end of the 18th century (Mowat 1981). Whalers of the 1740s saw whales whose descriptions matched those of the gray whale, but the existence of this species was not verified until fossil remains were uncovered (Allen 1942, Mowat 1981). Early Basque whalers had eliminated gray whales from European waters centuries before (Mowat 1981). Atlantic gray whales swam south along the shore of the coasts of Maine, Massachusetts and Long Island, down to the Florida Keys, where their calves were born (Mowat 1981). This whale, known as the "Scrag" in the Northeast, was a familiar species off the coasts of Nova Scotia and Maine in early colonial times. It gave rise to place names such as the Scrag Islands, Scrag Rocks and Scrag Harbor Œ now known as Sag Harbor (Mowat 1981). These whales fed in shallow bays on abundant bottom•dwelling crustaceans, making them easy prey for whalers. They were killed beginning in the early 1600s by harpooners off Nantucket Island, Cape Cod and Long Island Sound in the shallow shoals of their migration route (Mowat 1981). By the early 1700s, New England whalers had completely eliminated this whale (Mowat 1981).

Beginning in 1609, Samuel de Champlain sailed down the St. Lawrence River to the Great Lakes (Peck 1990). Other explorers and settlers established trading posts and villages. Furs were major items of trade, and soon beaver and other furbearers were traded in the millions by the French and English. Early travelers found wild turkeys (*Melagris gallopavo*) so abundant boys threw stones at them for recreation (Peck 1990). Two French explorers observed great numbers of fish in the Great Lakes and the upper Mississippi River, which soon became exploited. Vast numbers of cisco, members of the Salmonidae family, once lived in the Great Lakes. The Blackfin Cisco (*Coregonus nigripinnus*) and Deepwater Cisco (*Coregonus johannae*), native to Lake Michigan and Lake Huron, were considered "jumbo herring" by fishermen from early times (Day 1981). By the late 19th century, large fishing vessels with huge nets caught up to 15 million tons from one lake alone per year; one net haul might yield as much as 10 tons in a day (Day 1981). Fishing continued, even in winter, through ice holes, and prior to the availability of freezing facilities, dumping of unsold catches amounted to many tons (Day 1981). These fish became commercially extinct after World War I, and subsequently were declared extinct by the World Conservation Union, along with another Great Lakes species, the longjaw cisco (*Coregonus alpenae*) (Baillie and Groombridge 1996).

This overfishing was repeated in the Atlantic waters off New England and southern Canada. Cod, halibut and flounder abounded here, providing ample fish for centuries to local fishing communities. Huge cod weighing 180 pounds and halibut the size of barn doors were often caught in these times. Factory fishing ships began fishing here in the 1950s and soon depleted the stocks. National legislation banned these vessels from the Atlantic coast and smaller vessels took their place. With few restrictions on take Š and far too many fishermen Š the stocks crashed in the 1980s and early 1990s. With the encouragement of the National Marine Fisheries Service (NMFS), fishermen turned to small sharks known as dogfish. Within a few years, they also became depleted because of their extremely slow reproductive rate, a fact apparently not appreciated by the NMFS. Fishery conservation legislation has been enacted, but these stocks may never return to former abundance.

Some fisherman are being compensated for their boats by a federal program, in order to ease fishing pressure on remaining stocks, but others are turning to small fish, such as menhaden. These fish are fed on by humpback whales (*Megaptera novaeangliae*), threatened species not yet recovered from past whaling, as well as by puffins and other seabirds. Many seabirds are undergoing population decline as a result of a dwindling food supply and the drowning

risk posed by fishing nets. Shorebirds, too, are affected by overfishing. Horseshoe crabs (*Limulus polyphemus*) lay their eggs along the east coast each year, providing abundant food for shorebirds on their northward migration, and for many types of other wildlife as well. These crabs are captured by the millions for use as fish bait, which has reduced their numbers dangerously in some areas. The shorebirds have also declined precipitously in recent years, some species by 90 percent. Entire food chains are being disrupted as a result of over exploitation of the sea. Ocean pollution has contaminated Atlantic coastal waters, causing die-offs of dolphins, fish and manatees.

All along the East Coast, colonists built cities at river deltas, which were surrounded by vast salt marshes. These locations were considered prime seaport and manufacturing sites, and the marshes were filled in and polluted. Tens of thousands more acres of marshes along the Northeast coast have been ruined by construction of drainage ditches to control mosquitoes and halt malaria. In fact, these ditches created habitat for mosquito breeding and caused the water level in the marshes to drop. Waterbird populations declined sharply as a result, and they no longer filled their role as fish and shellfish nurseries, water filterers and flood controls. In a recent development, dikes in 10 thousand acres of marshes on Long Island are being blocked to open normal flow channels between marsh and bay, and exotic reeds are being removed (Lambert 1997). The marshes that have been returned to their natural state showed an immediate tripling in the number of waterfowl wintering there, and a doubling of wading birds such as ibis, egrets and herons; shorebird populations quintupled; these marshes have at least 130 species of breeding birds, and 300 species use them for wintering or migration (Lambert 1997). The marshes give a glimpse of the wealth of wildlife that once inhabited eastern coasts; with similar programs, they can be restored to help build up stock of fish and shellfish.

In most areas, however, housing and development now occupy the sand dunes and former marshes. Some barrier islands off the coasts, which buffer the beaches against the erosion effects of storms, have been preserved in portions of the East Coast, such as Virginia, North Carolina and Georgia. Elsewhere, roads, houses and businesses clutter these islands, and development has endangered many native birds. Georgia's beautiful coastal marshes were given official protection after they were nearly destroyed by phosphate mining, when it was shown that their value as shrimp and fish nurseries far outweighed their short-term value for phosphate.

At the southern tip of the United States, the Florida Everglades, one of the largest wetlands in the world, once provided nesting and feeding ground for millions of egrets, herons, pelicans and other waterbirds. This sawgrass wilderness sheltered vast numbers of American alligators (*Alligator mississipiensis*). Cougars, known as Florida panthers (*Felis concolor coryi*), were common, and preyed on the small Everglades white-tailed deer. Water diversion projects for agriculture and the new human population of Miami and coastal cities resulted in a drying out of the Everglades. Exotic plants have proliferated in the marshes, overwhelming the native grasses and choking waterways. Ninety percent of the populations of waterbirds disappeared. The Florida panther recently became extinct in Everglades National Park, one of its last refuges. The alligator has recovered from nearly disastrous hide hunting in Florida, but remains rare in many parts of its original range. A project to restore some of the waterflow to the Everglades was enacted into law in the 1990s (see Aquatic Ecosystems chapter).

The American crocodile (*Crocodylus acutus*), a saltwater species inhabiting coastal areas, was once numerous in Florida Bay and in the mangroves of the Keys. Today, this is one of the most endangered species in the country, numbering fewer than 400 animals. Early hide hunting reduced them and, in this century, pollution and loss of mangroves in their habitat have pushed this species close to extinction.

Many Everglades bird species are also endangered, and one has recently become extinct Š the dusky seaside sparrow (*Melospiza maritima nigriscens*). This sparrow, with its unusually dark coloration, was a victim of the massive destruction of wetlands in Florida. By the time it received the protection of the US Endangered Species Act, this subspecies was nearly extinct. Its limited habitat of spartina grass on Florida's central Atlantic coast had been flooded for mosquito control and drained for the construction of nearby NASA facilities (Ehrlich *et al*. 1992). In an 11th-hour attempt to save these little sparrows, a captive breeding program was set up, mating them with a related subspecies to preserve some of their genes. The last purebred dusky seaside sparrow died at the age of 13 in 1987 (Ehrlich *et al*. 1992). The breeding program was not successful, and by 1997, the related subspecies had also become

endangered.

Two spectacular waterbirds, the American flamingo (*Phoenicopterus ruber*), and the scarlet ibis (*Guara rubra*), were once residents of south Florida. Both species were eliminated in the 19th century when, as William T. Hornaday (1913) observed, they "attracted the evil eyes of the 'milliner's taxidermists.'" The feather trade of the late 19th century nearly exterminated the majority of North America's wading birds and many of its seabirds through unregulated slaughter for plumes to adorn ladies' hats. Egrets, roseate spoonbills, herons, terns and other birds with long or colorful feathers were killed indiscriminately. In 1900, the Lacey Act and state laws extended protection to these birds by banning sale and interstate commerce, and the Migratory Bird Treaty Act, signed with Canada in 1918, protected native North American non•game birds from capture, killing and sale.

The Eastern Forests

Ancient hardwood forests stretched for thousands of square miles in eastern North America. Massive oaks, chestnuts, hickories, walnuts and beech trees dominated, some reaching heights of more than 100 feet, with trunks 20 or more feet in circumference. Giant hemlocks and many kinds of pine dominated some areas. The passenger pigeon was the most abundant denizen of these forests, and its range extended from southern Canada, New England and the Great Lakes west to the Great Plains and south to Virginia. The slim bird was somewhat smaller than the familiar rock dove or common pigeon found in cities worldwide, with a long, pointed tail. The male's plumage was beautiful; his back, wings and head were bluish•gray with black streaks and spots, which contrasted with a rich, pinkish tinge on his lower throat. His breast feathers became paler on the belly, and a patch of pink or purple•pink iridescence shone at his neck. His eyes were bright red surrounded by purplish skin, and his legs and feet were red (Goodwin 1983). The female was a duller version of the male, browner gray above, light gray on the breast, with a smaller iridescent pink patch on the neck, more profuse black spots on the wings and gray skin surrounding her orange eyes (Goodwin 1983).

This is the only pigeon Š living or extinct Š that flocked and nested in vast numbers, darkening the sky during their migrations. When Europeans first encountered passenger pigeons, they were dumbfounded by their numbers. One immigrant, Pehr Kalm, described their passage in the spring of 1749: "on the 11th, 12th, 15th, 16th, 17th, 18th and 22nd of March . . . there came from the north an incredible multitude of these pigeons to Pennsylvania and New Jersey. Their number, while in flight, extended three or four English miles in length, and more than one such mile in breadth, and they flew so closely together that the sky and the sun were obscured by them, the daylight becoming sensibly diminished by their shadow" (Fuller 1987). When the pigeons landed on trees, their weight was sometimes so great that not only would large limbs break off, but entire trees would topple. Prior to settlement of the continent by Europeans, as many as 5 *billion* birds inhabited Kentucky, Ohio and Indiana alone (Blaugrund and Stebbins 1993).

Passenger pigeons were migratory, as their scientific name, *Ectopistes migratorius*, suggested, but not in the manner of most birds, who migrate from an ancestral nesting area to an ancestral wintering area. Instead, immense columns of birds flew as a unit at speeds estimated as high as 60 miles per hour in wide areas in search of nut trees and seeds. John James Audubon, famed illustrator of American birds, described flights in the 1830s that covered the sky for days in some areas, while in other years, none would be seen in the same area (Blaugrund and Stebbins 1993). The forests that once stretched nearly unbroken across eastern North America were crucial to the survival of the passenger pigeon flocks. Nut trees (oaks, hickories and beeches) produced large crops only every few years. In order to locate adequate feeding supplies, the pigeons covered great distances.

John James Audubon visited a roost in Kentucky accompanied by some pigeon hunters in 1831:

Many trees two feet in diameter, I observed, were broken off at no great distance from the ground; and the branches of many of the largest and tallest had given way, as if the forest had been swept by a tornado. Every thing proved to me that the number of birds resorting to this part of the forest must be immense beyond conception . . . Suddenly there burst forth a general cry of 'Here they come!' The noise which they made, though yet distant, reminded me of a hard gale at sea passing through the rigging of a close•reefed vessel. I felt a current of air that surprised me. Thousands were soon knocked down by the pole men. The birds continued to pour in . . . The pigeons, arriving by thousands, alighted everywhere, one above another, until solid masses as large as hogsheads, were formed on the branches all round. Here and there the perches gave way under the weight with a crash, and falling to the ground, destroyed hundreds of the birds beneath, forcing down the dense groups with which every stick was loaded. It was a scene of uproar and confusion. I found it quite useless to speak, or even to shout to those persons who were nearest to me. Even the reports of the guns were seldom heard, and I was made aware of the firing only by seeing the shooters reloading (Schorger 1973).

Once they located a forest with abundant food, they nested in huge aggregations. One colony in Wisconsin was estimated to cover more than 750 square miles, with 136 million nesting birds (Wilcove 1991). Audubon wrote of their courtship, "the tenderness and affection displayed by these birds toward their mates are in the highest degree" and painted two birds "billing" for his *Birds of America* series (Blaugrund and Stebbins 1993). Some described their courtship songs as a series of bell•like notes (Fuller 1987).

Their nests, constructed of loose sticks, held their single white egg. A tree could hold many nests, which the birds placed on strong branches close to the trunk. The flocks rarely nested in the same area two years running, and dispersed as soon as nesting was over; this may have been to prevent natural predators from increasing enough to have a serious impact on their numbers (Wilcove 1991). Also, their food supply tended to be abundant only every few years in a given area. These great colonies made easy targets for legions of meat and market hunters, beginning in the 1600s. By the 18th century, naturalists began to observe that nesting colonies were disappearing; the last great nesting in New England took place near Lunenburg, Massachusetts, in 1851 (Wilcove 1991). By the 1860s, the large flocks had been hunted out of coastal New York State and Pennsylvania. The few laws that were enacted to protect them in the Northeast were not enforced (Wilcove 1991). Season after season, pigeon hunters killed millions of these birds, destroying one colony after another.

Neltje Blanchan, in the 1904 book *Birds That Hunt and Are Hunted*, documented that unlimited netting, even during the nesting season, had resulted in sending more than 1 million pigeons to market from a single roost at the height of the hunting; an equal number of birds were wounded or left starving, helpless, naked chicks behind. Hunters shipped 100 thousand pounds of pigeons to market from a nesting colony near Grand Rapids, Michigan (Wilcove 1991). Audubon and other observers of the time described the brutal hunting methods: young birds were knocked out of their nests with poles, and captive pigeons, whose eyelids had been sewn shut, were tethered to lure wild pigeons to the ground where they were netted (Wilcove 1991). Nesting trees were cut down or set afire, and sulphur was burned under nesting trees to kill the birds (Wilcove 1991). Blanchan (1904) described the glut of pigeons at markets as so great that the price per barrel scarcely paid for their transportation. The pigeon meat was often fed to hogs.

By the late 1800s, it had become evident to some that the killing was having a disastrous effect on the passenger pigeons. The warnings went unheeded, however. In Ohio, a bill submitted in 1857 to protect the passenger pigeon received the following report from a Select Committee of the Senate: "The passenger pigeon needs no protection. Wonderfully prolific, having the vast forests of the North as its breeding grounds, traveling hundreds of miles in search of food, it is here to•day and elsewhere to•morrow, and no ordinary destruction can lessen them, or be missed from the myriads that are yearly produced" (Hornaday 1913).

The final and precipitous decline of passenger pigeons began in the 1870s, a decade which began with some large flocks still attempting to nest in the Great Lakes area. In 1878, naturalists estimated that some 50 million pigeons survived, but with continued heavy hunting, only one large nesting colony in Wisconsin remained in 1887 (Wilcove

1991). This colony dispersed within two weeks after beginning to nest when hunters began shooting at them (Wilcove 1991). By the 1890s, only scattered individual pigeons Œ who were apparently unable to breed or forage successfully Œ remained. In 1892, one observer noted, "The extermination of the passenger pigeon has progressed so rapidly during the past twenty years that it looks now as if their total extermination might be accomplished within the present century" (Blanchan 1904). This statement proved correct. The incredible wildlife spectacle that flights of billions of passenger pigeons presented, ended completely on March 24, 1900, when the last wild bird was killed in Pike County, Ohio (Wilcove 1991).

The reason for the sudden crash in passenger pigeon numbers has been the subject of controversy in the years since. Two ornithologists from the University of Minnesota, David E. Blockstein and Harrison B. Tordoff, believe during the last 20 years prior to its wild extinction, hunters were able to disturb or destroy virtually every nesting colony. Each year, the adult birds that were able to escape previous hunting and attempt breeding were harassed or chased off the nest, or their fledglings were killed (Wilcove 1991). The adults not killed were relatively long-lived, averaging a lifespan of about 20 years, but because their numbers were not replaced by succeeding generations, when they died off, the species became extinct (Wilcove 1991). Blockstein and Tordoff noted some Passenger Pigeons nested in small groups, escaping the attention of hunters, but they conjectured that without the protection provided by large colonies, these birds rarely succeeded in producing fledgling chicks, and were easy targets for predators (Wilcove 1991). This explanation seems logical, and clearly, the birds were unable to survive in small, scattered groups, dependent on a large colony for successful reproduction. Other factors may also have entered in. It may be that only in the presence of large numbers of their own kind was instinctive breeding behavior stimulated.

A captive passenger pigeon named Martha, about 29-years-old and the last of her species, died at 1 p.m. on September 1, 1914 at the Cincinnati Zoological Gardens. This is perhaps the only species for which the exact minute of its extinction is known (Fuller 1987).

Logging and settlement of the eastern hardwood forests destroyed forever the ancient habitat of these lovely pigeons. Even if the passenger pigeon was somehow recreated, the huge expanses of nut and seed-bearing trees it required have since been cut. More than 99 percent of virgin woodland in the East has been logged, first by settlers, and later by commercial loggers. The colonists of New England, after destroying the forests, found farming the rocky soil difficult and unproductive. The short growing season, often interrupted by frosts, further limited agriculture there. Most of these farms were abandoned, and today, second-growth forest covers the region. However, it is composed of different species of trees than the original old-growth forest and is far poorer in wildlife.

The American chestnut (*Castanea dentata*) once comprised a third of eastern hardwood forests; a huge tree 100 feet tall with a spreading canopy, it had girths up to 12 feet (Jonas 1993) and produced bountiful crops of chestnuts. American chestnuts grew east of the Mississippi River from Maine south to Georgia. Of the 12 species of chestnut trees worldwide, the American was known for yielding the tastiest nuts (Jonas 1993). After heavy logging, older trees became confined to wilderness areas and towns, where they were greatly admired as shade trees. In 1904, the spores of a fungus known as chestnut blight were accidentally introduced to the country, probably on seedlings of imported Chinese chestnut trees (Jonas 1993). The blight destroyed the remaining chestnuts in the eastern forests, leaving only stumps. These stumps still sprout shoots that grow up to 20 feet until they, too, succumb to the blight (Jonas 1993). Only a few unblighted American chestnut trees remain in the country. On the West Coast, a small number of the trees were planted out of their natural range, and the blight did not reach them (Jonas 1993). Progress is being made in breeding disease-resistant strains of this tree (see Forests chapter and Projects section).

Another eastern hardwood, the stately American elm (*Ulmus americana*), which reaches heights of 60 to 120 feet, has a slim, straight trunk and a broad, graceful crown. It is also nearly extinct; it was attacked by a fungal infection known as Dutch elm disease, which is gradually killing off these trees. First seen in 1930, the disease spread west. It is still in the process of eliminating trees throughout their range in North America from Nova Scotia to Saskatchewan, south to Florida and west to Texas (Jonas 1993). A disease-resistant strain of this tree has also been bred, and the trees are being distributed for free by a nonprofit organization (see Forests chapter and Projects section).

American beeches (*Fagus grandifolia*) were perhaps the most important food tree for wildlife, producing massive amounts of beech nuts on which passenger pigeons, wild turkeys, black bears and other wildlife fed. At 50 to 70 feet tall, beeches have short, wide trunks that begin branching 10 feet from the ground and form enormous, wide crowns (Jonas 1993). The species is still fairly widespread, but old American beeches, which can live 400 years and grow to enormous girths, are extremely rare in woodland settings where they have been logged out.

Ironically, the colonists could have lived well off the land they found if they had not destroyed both the forests and much of the wildlife within a few centuries. The abundant nuts produced by hardwoods, which had nourished the passenger pigeons, also provided food to Native Americans. Many tribes had learned to remove the tannin from acorns so it could be ground into nutritious high-protein flour. Beechnuts, chestnuts, walnuts, hickory nuts, wild fruits and seeds provided excellent food for people as well as wildlife.

European settlers destroyed this rich ecosystem by commercializing the resources, turning ancient forests into short-term logging profits and wild birds, deer and furbearers into commodities. Had another road been taken, the natural environment would have endured with ample resources for all to live on. Many native tribes had cleared some forests for agriculture, but the vast majority remained in their natural state. Settlers, later supported by government policy, claimed ownership of the East and then proceeded to oust native peoples or relegate them to tiny reservations. This resulted in the killing of hundreds of thousands of natives and the extinction of many tribes.

The new Americans, in adopting the European approach to nature, tamed the wilderness and began a program of eliminating natural predators. They considered the reverence with which Native Americans had treated all living things to be a weakness. At the time of European colonization in the 17th century, almost no natural forests remained in Western Europe. Large predators had been eliminated from most of Western Europe, and most wildlife had been crowded out, killed off or confined to private estates where the animals were considered the property of landowners, providing food and sport to the upper classes. Moreover, this wildlife was hardly wild, but semi-tame. Deer lacked predators, the woods on estates were stocked with game birds and the streams with salmon and trout by gamekeepers. The vast majority of European settlers came from the lower and middle classes; they had previously been denied the right to hunt and were eager to do so with abandon. This was another motivation for the relentless slaughter that decimated wildlife during this period.

Benjamin Franklin hoped to make the wild turkey the official symbol of the United States. When colonists arrived, the species was abundant in eastern forests. Uncontrolled hunting and the cutting of forests eliminated these birds from state after state: Connecticut by 1813, Massachusetts by 1851, New York in the mid•1800s, South Dakota by 1875, Ohio by 1880, Wisconsin by 1881, Michigan by 1897, Illinois by 1903, and Iowa by 1907 (Burger 1978, Peters and Lovejoy 1990). Fortunately, the species was not destroyed altogether, and it has been reintroduced into many parts of its original range through transplants from remnant populations.

Once the eastern forests echoed with the howls of gray wolves (*Canis lupus*), common throughout the continent except the Southeast, where the smaller red wolf (*Canis rufus*) roamed. Both these wolves were deliberately persecuted into extinction by colonists who placed bounties on their heads, effectively eliminating them from the wild in the eastern United States prior to the 20th century (see Persecution and Hunting chapter). Seven races of the gray wolf are now extinct, bountied and poisoned by settlers. Around 1911, the Newfoundland race, *Canis lupus beothucus*, was the first to become extinct. This pure white, large wolf had a scientific name inspired by the Beothuk Indian tribe of Newfoundland; both the wolf and the tribe were exterminated by Europeans (Day 1981).

The red wolf became extinct in the wild in the 1970s, after centuries of persecution and habitat loss. Two subspecies, the Florida black wolf (*Canis rufus floridanus*) and the Texas red wolf (*Canis rufus rufus*), are extinct, and only one race survives. The last members of the species were taken into captivity and bred successfully. A reintroduction program in portions of its original range has brought the species back, and about 100 red wolves now live in the wild. The cruelty with which the gray wolf was eliminated is described in detail in the Persecution and

Hunting chapter. Another predator once common in these forests north of Florida was the Eastern cougar (*Felis concolor couguar*). It was also bountied and hunted until it became extinct throughout the eastern United States.

In the northern woods, eastern subspecies of the American bison, elk, caribou, moose and white•tailed deer were extremely common. The hunting by Native Americans armed with bows and arrows did not, apparently, cause declines. The guns brought by Europeans, however, decimated their numbers. An unrestricted slaughter of these ungulates went on for centuries. The white-tailed deer became endangered, disappearing from the eastern forests, first from the vicinity of towns and habitations, then from wilderness areas. The other ungulates died out altogether in New England and the middle Atlantic area. The Eastern elk (*Cervus elaphus canadensis*) became extinct. One cause for the disappearance of this huge member of the deer family was hunting to obtain its teeth, which a private organization, the Fraternal Order of the Elks, used as watch•chain insignia (Day 1981). Not only were these animals hunted for food and sale in meat markets by the colonists, but an active export trade in deer and elk skins sprang up. Records show an average of 100,000 of these skins exported to England each year between 1778 and 1808 (Poland 1892). Several small populations of reintroduced elk inhabit Pennsylvania, North Carolina, Tennessee and Virginia.

Hunting caused the extinction of the Eastern bison (*Bison bison pennsylvanicus*) by 1800. This race of bison was larger than the plains bison and very dark; some of the bulls were coal black with grizzly white hair around the nose and eyes (Allen 1942). The last herd of Eastern bison was slaughtered in Union County, Pennsylvania in the winter of 1799 to 1800, as the animals huddled helplessly in the deep snow; the last individuals of this race were killed near Charleston, West Virginia in 1825 (Allen 1942).

Caribou (*Rangifer tarandus*) and moose (*Alces alces*), native to northern New England and southern Canada, were hunted to extinction in the United States in colonial times, surviving only in Canada (Allen 1942). The white•tailed deer has reoccupied its former range in the northeastern United States and, in fact, these deer have become overpopulated as a result of a lack of natural predators (see Persecution and Hunting chapter). The moose has been reintroduced in recent years to New England and is gradually dispersing southward. Attempts to reintroduce caribou in Maine have failed.

The heath hen (*Tympanuchus cupido cupido*) was another casualty of colonial settlement. This eastern subspecies of the greater prairie chicken, a grouse•like bird, was native to forest edges, grassland and heath in portions of the Northeast, from Massachusetts to Pennsylvania and New Jersey (Greenway 1967). Pursued by market hunters, these birds became a staple food for colonists. Heath hens were so common in Massachusetts in colonial times that Governor Winthrop ordered his servants not to have them served more often than a few times a week (Greenway 1967). By 1830, the last mainland Massachusetts heath hen was shot in the western part of the state. In New York State, a 1791 law banned hunting of these birds during spring and summer, but the law was flouted, and market hunting on Long Island resulted in its extinction there by 1844 (Greenway 1967). Overhunting in New Jersey and Pennsylvania killed off the last birds in these states by the 1860s. The last population of these birds survived on Martha's Vineyard island off the Massachusetts coast and, although protected from hunting, fire and predation gradually eliminated them by 1932 (Greenway 1967).

The existence of brilliantly colored parakeets flying in large flocks in eastern North America was an unexpected surprise for European colonists settling the country. They had thought such birds lived only in tropical regions. Yet these parakeets obviously had adapted to winter snows and frigid nights. The species was named the Carolina parakeet (*Conuropsis carolinensis*) and had a long, graceful tail and a bright yellow and orange head. Its green wings were tinged with yellow, set off by its overall forest green plumage. Eastern parakeets belonged to the subspecies *Conuropsis carolinensis carolinensis* and ranged from Florida to southern Virginia, while western parakeets, *Conuropsis carolinensis ludovicianus*, had a wide distribution from the Mississippi-Missouri River drainage south to Texas, east to Mississippi and north to western New York State and the Great Lakes region (Forshaw 1989). These birds flew in enormous flocks and may have numbered in the millions prior to European settlement.

Like conures (*Aratinga* genus), native to the Caribbean and Latin America, Carolina parakeets could give away

their presence by loud and raucous calling. Because they fed on many types of wild seeds and fruits and were able to endure freezing temperatures, they were among the few species in the parrot family able to survive in harsh climates, with the ability to tolerate temperatures as low as -25 F. (Cokinos 2000). Early travelers in Kansas described the appearance of screaming bands of these parakeets during swirling winter snowstorms; flocks settled in groves of cottonwood and walnut trees, delighting travelers with their vocalizing and dazzling colors (McKinley 1985). Large, hollow trees were among their favorite roosting spots, and flocks of birds would cling to the inside of the trees with their beaks and feet (Forshaw 1989). In early morning, the birds would climb to the top branches of their roosting trees, to the accompaniment of much chattering, and then fly off to feed for several hours. When they saw a fruit or seeding tree, the flock would spiral down until they almost reached the ground, and then rise up to alight on the branches. In the afternoons, they sheltered in groves of trees, often near streams where they drank and bathed (Forshaw 1989).

These parakeets may have been most abundant in the South and the major river valleys of the Midwest. Early naturalists described them perched in huge Bald Cypress trees, their bright plumage contrasting with the pale green, feathery foliage. They would hover and flutter on the tops of these cypresses, extracting the seeds (McKinley 1985). Travelers in the southern hardwood forests and swamps, as well as in pine woods, found them very numerous. In Florida's St. John's River area, where mid-19th century observers saw large flocks, many were killed by plantation owners for food (McKinley 1985).

In Audubon's painting of Carolina Parakeets, these extremely sociable birds are clustered in a tree, feeding on Cockleburs (*Cenchrus tribuloides*), their favorite food (Blaugrund and Stebbins 1993). Only recently have the true colors of this bird, as depicted by Audubon, been revealed by a publication of his original watercolors, which shows their plumage in shades of vivid green, yellow and reddish orange. In the lithographs of previous editions, these colors were drab and dull (Blaugrund and Stebbins 1993).

As their forests were cut and prairies plowed for farms, the parakeets turned to raiding crops and orchards. Flocks would converge on farms at times of harvest, alighting on stacks of grain sheaves. So dense were the perching and feeding birds that they made the stacks look as if "brilliantly colored carpets had been thrown on them," according to Audubon (Forshaw 1989). For these raids on farms, they received "severe retaliations" from farmers; Carolina parakeets were easily approached and never learned to fly away from humans. Farmers would shoot entire flocks, killing 10 or 20 at each discharge (Forshaw 1989). When one was shot, the others refused to leave their wounded or dead flock mate. Audubon described these massacres: "The living birds, as if conscious of the death of their companions, sweep over their bodies, screaming as loud as ever, but still return to the stack to be shot at, until so few remain alive, that the farmer does not consider it worth his while to spend more on ammunition" (Poattie 1940).

Like many members of the parrot family, Carolina parakeets attempted to aid others of their kind who were stricken or threatened by predators. This behavior contributed to their survival in natural conditions, and only the devastating killing power of guns hastened their extinction. Audubon described procuring a basketful of the parakeets with a few shots in 1831 in order to choose good specimens for drawing the figures for his watercolors of North American birds (Fuller 1987). Thousands more of these parakeets were captured for the pet trade and killed for museum collections. At least 675 of the eastern race alone are found in museums. In the last decades of the 19th century, amateur collectors of specimen birds and their eggs proliferated around the country, and dealers in specimens earned large sums from the sale of rare birds. The rarer the bird, the higher the price paid, further endangering the species. Many birds were killed for specimens by collectors who failed to note the location and date of the killing (McKinley 1985). Molting adults and juvenile birds were thrown out, and the physical appearance of the latter birds remains unrecorded (McKinley 1985). One German taxidermist, August Koch, visited the home of a friend in Florida in 1887 and shot some of these parakeets in the back yard of his host as they fed on mulberries (McKinley 1985). A tree that appeared to be sporting "yellow flowers with red centers," turned out to be a flock of parakeets roosting in the early evening, and he shot two birds for his collection (McKinley 1985). Another hunter was led by a Seminole Indian to a "parakeet tree," a large, hollow cypress tree near Lake Okeechobee in Florida, where he shot "as many specimens as my ammunition would allow" (McKinley 1985).

In spite of the keen interest in the species by scientists, naturalists and members of the public, few observations were made of the behavior of these parakeets while they were still common. Almost nothing is known of their life history, flock movements, breeding seasons, nesting, feeding or ecology (McKinley 1985). It is known, however, that they were long-lived, based on the survival of the last captive specimens, which were at least 32 years old. Although a few bred in captivity, they often abandoned their eggs, and no captive-bred birds survived (Forshaw 1989). In spite of large numbers captured for sale as cage birds, no serious effort was made to perpetuate the species through captive breeding, which might have prevented their extinction.

As early as 1831, Audubon noticed a decline: "Our parakeets are very rapidly diminishing in number; and in some districts, where twenty-five years ago they were plentiful, scarcely any are now to be seen" (Forshaw 1989). Flocks of several hundred had commonly been seen when the country was first settled. Within about 90 years, by the 1880s, they had declined both in range and number, with only small flocks or pairs remaining (Forshaw 1989). Persecution by farmers was a major cause Š and perhaps the most important factor Š in the decline of the Carolina parakeet in the view of parrot ornithologist, Joseph Forshaw (1989). The last flocks sought refuge in the forests and remote swamps of Florida, where collectors and trappers pursued them (Forshaw 1989). Other factors played important roles as well. Thousands were killed for sport or for their feathers to decorate ladies™ hats. Their nesting and roosting trees were cut by settlers and loggers, and their food plants were plowed under by farmers (Cokinos 2000). European honeybees, armed with stingers and introduced by colonists, also may have driven them from their hollow trees as they rapidly spread throughout the country, seeking hive sites (Cokinos 2000). These hollow tree-roosting sites may have been crucial to their survival in cold weather; the birds crowded together side-by-side for warmth. The giant hollow cypresses and sycamores, oaks and other hardwoods in the old-growth forests of the eastern United States, crucial habitat to so many species of wildlife, were among the first trees cut in bottomland swamps and forests.

A few Carolina parakeets survived into the first years of the 20th century, with sightings reported in the Panhandle and the Kissimmee Prairie of north-central Florida (McKinley 1985). The last wild specimen was taken in either 1901 or 1904; the date is still in dispute (Cokinos 2000). A flock of 13 of these birds was seen near Lake Okeechobee, Florida in 1920, and two eminent ornithologists, Alexander Sprunt and Robert Porter Allen, went in search of the last members of the species in 1936. They reported seeing a flock along the Santee River in South Carolina, but the National Audubon Society later dismissed the account (Forshaw 1989). In any case, the area was later destroyed for construction of a power project (Forshaw 1989). No confirmed sightings were made after about 1920, although a black-and-white home movie made in 1937 showed some parakeets in the Okefenokee Swamp of southeastern Georgia that *may* have been of this species (McKinley 1985). Had the Carolina parakeet been accorded legal protection and reserves set aside during the 19th century, this spectacular species would almost certainly still be alive.

A pair of Carolina parakeets kept at the Cincinnati Zoological Gardens Œthe same zoo that housed Martha, the last passenger pigeon Œ was the last known members of their species. Sixteen of these parakeets were purchased by this zoo in the 1880s for $2.50 per bird (Fuller 1987). Over the years, the birds laid eggs, but none hatched or were even incubated, and gradually they died off until only a pair was left Š cage-mates for 32 years (Fuller 1987). In the late summer of 1917, the female, Lady Jane, died. Incas, the male, became listless after her death, and in February 1918, he died of grief, the keepers claimed (Fuller 1987).

The old-growth pine and mixed hardwood forests of the Southeast, as well as Cuba, were home to a large and noisy bird that may have disappeared. The ivory•billed woodpecker (*Campephilus principalis*), at 18 to 21 inches long, is the largest woodpecker in the United States or Canada and the second largest in the world. Elegant in appearance, both male and female are predominantly black, with stripes of white feathers on both sides of the neck; the lower half of their wings is white, as is the enormous bill for which the species was named (Short 1982). Their drumming on dead tree trunks once reverberated in the forests as they removed strips of bark a foot or more long to uncover beetle larvae. They also drummed as a territorial signal, trumpeted and made a call that sounded like a child™s tin horn. Their vocal repertoire also included a soft call between male and female perched side-by-side while changing places

incubating eggs in their high nest holes (Cokinos 2000). Never heard by scientists observing them in the wild, the ivory-billed woodpeckers uttered an extraordinary screech when captured and transported away from their forest, as described by ornithologist and artist Alexander Wilson early in the 19th century (Cokinos 2000). Wounding an adult male to use as a subject for a painting, he was astonished to hear him utter fia loudly reiterated and most piteous note, exactly resembling the violent crying of a young childfl (Cokinos 2000). The bird continued to scream loudly as he was carried in a container to a town nearby, alarming people who took the noise for that of a child. Wilson rented a room where he planned to paint him, and the frantic bird began drumming on the wall, breaking off huge chunks of plaster, and damaged a mahogany table. Although offered food, the distraught bird refused to eat and died within three days (Cokinos 2000).

The ivory-bill's decline came as a result of heavy logging begun in the 18th century, which destroyed millions of acres of old-growth pine and hardwood bottomland forest in the Southeast. Each pair required a territory of at least 6 square miles of mature forest, and as their forest disappeared, ivory-billed woodpeckers became so rare that few were seen after 1900 (Cokinos 2000). Hunting also made inroads into their populations. These birds made large targets and were so conspicuous and noisy that they attracted the attention of meat and sport hunters in the 19th century. At that time, few people walked in the woods without a gun; most people took shots at any large bird or mammal.

Over-collecting of specimens by museums was another factor in the extinction of the ivory-billed woodpecker. Its size, beauty and natural rarity brought museum collectors from around the world to scour forests in the South for the last specimens of this bird. There are 400 known museum specimens worldwide (Day 1981), and most of these were taken in the last years of the 19th century, when the species had become extremely rare. Nineteenth century museum curators often sent collectors out to obtain specimens of very rare animals after they received word that the species was headed toward extinction. Responsible modern natural history museum curators do not routinely collect rare animals, but reach agreements to allow very limited collection of newly discovered species, usually only by the scientist who made the discovery. Most museums now loan specimens to scientists who wish to examine them.

Dr. Lester Short (1982), an authority on woodpeckers, believes the ivory-billed woodpecker's original habitat was probably the virgin pine forests that once covered much of the Southeast. They had become confined to hardwood swamp forests in Louisiana, which was probably not ideal habitat for them (Short 1982). Upon the discovery of a small number of Ivory-bills in a forest along the Tensas River in Louisiana, Cornell University scientists organized an expedition to film and record these birds. They later designated a young Ph.D. ornithologist, James T. Tanner, to study these last birds in the wild. In his study, *The Ivory-billed Woodpecker*, published in 1942, he estimated that at that time, no more than 22 of these woodpeckers remained in the United States. His investigation centered on the only known population of ivory-billed woodpeckers in the 120 square mile old growth forest. The Cornell team filmed the birds drumming on trees and recorded their various calls. This film is part of Stouffer Productions' fiAt the Crossroadsfl film. (See Video section, Endangered Species, General.) These recordings are retained in the Cornell Ornithological Library of bird songs, along with motion pictures of a pair of woodpeckers.

Tanner documented the presence of seven pairs and four young in 1934. He also traveled extensively in the Southeast, where ivory-billed woodpeckers were seen in the past, asking local people for sightings and listening for their unique calls; he was unsuccessful. From 1931 to 1939, the last remaining birds raised 19 young. They declined as he was observing them, however, and by 1939, only six ivory-billed woodpeckers Š one pair, one young bird and three males Š remained in these woodlands (Cokinos 2000). They had lost the majority of their habitat after the Singer Company sold the logging rights for these 80 thousand acres to Chicago Mills in 1937, and the old growth forest was rapidly leveled. Some of the birds may have been shot for the $1,000 collectors were willing to pay (Cokinos 2000). In the early 1940s, the National Audubon Society™s president appealed directly to President Franklin Roosevelt to spare the ivory-bills™ last habitat, and the Secretary of the Interior was ordered to consider the matter (Cokinos 2000). Various federal agencies and the War Production Board agreed these trees could be spared for the war effort. These agencies and four state governors urged Chicago Mills to protect this forest (Cokinos 2000). The State of Louisiana offered the company $200 thousand as compensation in December 1943, but it refused, and attempts in the US Congress to pass legislation to mandate protection of the Singer woodlands failed as well (Cokinos 2000). This company remained indifferent to the fate of the woodpeckers, red wolves, mountain lions, black bears

and abundant birdlife being destroyed to produce chests to ship tea to the English Army (Cokinos 2000).

Unknown to conservationists and government agencies was the fact that it was already too late. Richard Pough, a National Audubon Society employee, was sent to search for any remaining ivory-billed woodpeckers in the Singer woodlands in December 1943. He saw the last ivory-billed woodpecker, a lone female, and noted in January 1944: fiIt is sickening to see what a waste a lumber company can make of what was a beautiful forest. Watched them cutting the last stand of the finest sweet gum on Monday. One log was 6 feet in diameter at the buttfl (Cokinos 2000). This may have been the same female and her fledgling chick seen by Tanner in 1941, the only birds remaining at that time (Cokinos 2000). A wildlife artist, Don Eckelberry, heard of the disastrous situation for this species and traveled to the Singer woodlands to paint this female ivory-billed woodpecker. His observations constitute the last authenticated sightings of the species in the United States (Cokinos 2000).

Many searches have been made throughout its once wide range, which extended from southeastern Oklahoma and Missouri north to Indiana and east through northern Florida. Sightings have been made of these birds over the years in Florida and Mississippi, but none was authenticated by photographs or recordings (Cokinos 2000). The last 20th century observation was made on April Fool™s Day, April 1, 1999, by a forestry student along the Louisiana-Mississippi state line, in the Pearl River basin (Cokinos 2000). He claimed to have seen a male and female at close range in a swamp forest (Cokinos 2000). Subsequent searches of this forest by ornithologists and others failed to find any trace of ivory-billed woodpeckers (Cokinos 2000).

There is slim hope that the species might survive either in the United States or in Cuba. These birds were seen in Cuba™s southeastern pine forests during the early 1980s, but this population dwindled and disappeared by 1991 in spite of a reserve that had been set aside for it (Collar *et al.* 1994). In 1998, evidence of its possible survival in Cuba consisted of some likely sightings in the Sierra Maestra highlands, where it had never been seen before (BI 2000; Garrido and Kirkconnell 2000). Although unlikely, it would be a truly exciting event if the magnificent ivory-billed woodpecker survived in spite of the almost total loss of its habitat.

Bachman's warbler (*Vermivora bachmanii*), a small yellow songbird of the southeastern United States, has not been seen for decades. John James Audubon painted a pair of these birds without ever having seen them alive. The species was discovered in 1833 by his close friend, John Bachman (Blaugrund and Stebbins 1993). Audubon's painting was based on specimens sent to him by Bachman. He depicted the Bachman's warbler posed stiffly on a Franklinia tree (*Franklinia altamaha*), an equally mysterious species with large white flowers. Discovered in the South in 1765 by the noted botanists William and John Bartram, this beautiful tree was named in honor of Benjamin Franklin (Blaugrund and Stebbins 1993). In spite of thorough searches in the area in Georgia where the tree was found, the Franklinia was never seen in the wild again (Blaugrund and Stebbins 1993). Fortunately, the Bartrams had taken cuttings of the tree for cultivation, and this tree is now grown in botanical gardens and nurseries throughout the world. Bachman™s warbler became very rare after 1920.

Originally, these warblers ranged from the lower Mississippi River and east Texas, north to southern Indiana, and along the east coast from Georgia north to southern Maryland (Hamel 1995). The species' original habitat was southern bottomland, hardwood forest with extensive cane (*Arundinaria gigantea*) thickets (Hamel 1995). Clearance of these forests in the 19th century and first decades of the 20th century, both in the United States and in Cuba, where it wintered, eliminated the majority of its habitat. It is not known to what extent it used canebrakes and bamboo thickets growing on bottomlands, but these were the last habitats in which it was seen.

A 19th century observer of Bachman's Warblers, O. Widmann, entered bottomland forests in the Mississippi Alluvial Valley, and wrote in 1897, "I had no trouble in finding several singing males on the day of my arrival– In the wildness of his home it takes several minutes to follow him over fallen trees and around impenetrable thickets or pools of water" (Hamel 1995). Widmann saw its nest "tied very slightly to a vertical blackberry vine of fresh growth– From above, it was entirely hidden by branchlets of latest growth– to reach the place it was necessary to go through pools of water and heaps of fallen trees and brush. Such sheltered places are probably chosen to avoid the

danger of being trampled down by hogs and cattle roving in these woods" (Hamel 1995). This wild region was a mixed habitat of sweetgum, blackgum, tulip trees, mulberry, ashes, cottonwood, hackberry and hardwoods; Bachman's warblers were seen mainly in the higher portions, which were also those first cleared (Hamel 1995).

Approximately 400 scientific specimens were collected for museums, and this may have reduced its population at a time when it was already rare (Hamel 1995). The last nest was found in 1937, and much of this species' life history remains a mystery. Intensive searches have been carried out by biologists for this bird; a total of 7,000 hours were spent between 1975 and 1979 combing likely habitat areas in South Carolina, Missouri and Arkansas. In 8,000 hectares (19,768 acres) of apparently suitable habitat, no Bachman's warblers were seen or heard (Hamel 1995). As recently as 1980, an unconfirmed sighting was reported in Cuba, but the last confirmed sighting of a Bachman's warbler was in 1961 near Charleston, South Carolina (Hamel 1995). An unconfirmed sighting was made in 1988, but none have been seen since (BI 2000).

Endless Grassland

Stretching more than 1,000 miles from Illinois west to the Rocky Mountains, and from southern Canada south to Texas, the North American Prairie seemed endless. In the Midwest, tallgrass prairie interspersed with oak trees dominated, and farther west, in a north-to-south band, was an immense shortgrass prairie. Through its center flowed the Mississippi and Missouri Rivers, their confluence creating one of the world's greatest rivers. Lining the rivers were hardwood forest swamps from the Mississippi Delta at the Gulf of Mexico north to the Missouri River, where river otters, muskrats, beaver, mink and raccoon abounded. A vast mosaic of wetlands, known as "prairie potholes," dotted the northern Plains states and, during the spring, turned into ponds and marshes, making them perfect breeding areas for millions of waterfowl and shorebirds.

An estimated 50 million American bison (*Bison bison*) thundered across the prairie in a spectacle rivaling the migration of today's East African wildebeests, and far exceeding them in number. While the passenger pigeon may have been the most numerous bird in Earth's history, the bison is considered the most numerous large mammal to ever have lived on the planet. Coexisting with these bison were Plains tribes of Native Americans Š Pawnee, Blackfoot, Crow, Ojibwa, Sioux, Mandan, Comanche and others.

In 1804, President Thomas Jefferson commissioned Meriwether Lewis and William Clark to travel across the newly acquired Louisiana Territory west to the Pacific to conduct the first natural history survey of the American West. Clark described the prairie near the Missouri River as "rich, covered with grass from 5 to 8 feet high, interspersed with copses of hazel, plums, currents, –raspberries and grapes of different kinds" (Peck 1990). Lewis's journal entry records his awe of the landscape: "Nor do I believe that there is in the universe a similar extent of country. As we passed on, it seemed as if those scenes of visionary enchantment would never end."

Throughout their travels they saw "immense herds of buffalo, deer, elk and antelopes," some "so gentle that we pass near them without appearing to excite any alarm among them" (Peck 1990). Wolves and foxes were common, along with animals they had never seen before Š pronghorn antelope, jackrabbits, prairie dogs, coyotes, grizzly bears and many beautiful prairie birds (Peck 1990). One of the purposes of their journey was to assess the marketable potential of the wildlife, especially furbearers. Their observations paved the way for the fur trade and slaughter of wildlife that effectively eliminated large mammals from the Great Plains by the end of the century.

A visual record of the original prairie was made by various artists, the most famous of which was George Catlin, whose magnificent portraits of the Native Americans, American bison and landscapes preserve them for posterity. It

was Catlin who proposed this wild land be protected:

Nature has nowhere presented more beautiful and lovely scenes, than those of the vast prairies of the West; and of man and beast, no nobler specimens than those who inhabit themŠthe Indian and the buffaloŠjoint and original tenants of the soil . . . And what a splendid contemplation too, when one imagines them as they might in future be seen (by some great protecting policy of government) preserved in their pristine beauty and wildlife, in a magnificent park . . . A nation's Park, containing man and beast, in all the wild freshness of their nature's beauty (Peck 1990).

The world's first national park, Yellowstone National Park, was set aside in 1872, protecting some 2 million acres of mixed grassland and forest and the last wild bison in Montana and Wyoming, but Native Americans were excluded. The huge prairie park, as envisioned by Catlin in the central part of the continent, has not been established. It would have been a biological treasure for future generations. A tallgrass prairie national park was established in the 1990s, and perhaps in the future, a large national park will preserve portions of the once vast shortgrass prairie.

The US government encouraged the slaughter of bison as part of a deliberate campaign to vanquish the Plains tribes by removing their means of subsistence; the slaughter was also a free•for•all hunting spree by crews working on the transcontinental railroad after 1830 (Allen 1942). Thousands of bison were killed just for their tongues, which were considered a delicacy. The commercialization of the bison sealed its fate. In 1840, the American Fur Company sent 67,000 robes of bison hides to St. Louis, a fur trading center (Allen 1942). In the upper Missouri country, 250 thousand bison were killed annually until the 1870s; during this decade, just as in the case of the passenger pigeon, the slaughters turned the tide for the species (Allen 1942).

With the completion of the railroad, the great herd became split in half, and migrations that once took them from Montana to Texas were ended by a shooting spree lasting until the late 1880s (Allen 1942). In Dec. 1877 and Jan. 1878, the "last great slaughter" took place on the isolated southern herd of Kansas, Oklahoma and Texas; 100 thousand hides were taken by an army of hunters, wiping out this herd (Allen 1942).

Only the protection of two small herds in Yellowstone National Park and Wood Buffalo National Park in Alberta, Canada, totaling about 541 individual bison, prevented the extinction of the species (Allen 1942). Even the 300 bison in Yellowstone were nearly killed off by poachers between 1890 and 1893; 270 animals were shot illegally, leaving only 30 in the park (Hornaday 1913). These few wild bison stayed as far as possible from tourist routes, and by 1912 the herd had grown to 49 (Hornaday 1913). Since then, herds have been re•established in several parks in the West. There are now more than 150 thousand bison, but the majority is ranched animals, bred for docility. Even these represent a tiny fraction of their former numbers. Pure strains of American bison can be found only in the herds of Yellowstone and Wood Buffalo National Parks.

Other grassland wildlife was slaughtered for the meat trade. Among the millions of shorebirds that migrated through the Great Plains and bred there was a mousy brown, medium•sized bird known as the Eskimo curlew (*Numenius borealis*). These birds were known to many market hunters as "prairie pigeons" or "doughbirds" because of the thick layer of fat the bird added before migration (Ehrlich *et al*. 1992). This bird became the prairie equivalent of the passenger pigeon Œ an ominous comparison that signaled its ultimate fate. Eskimo curlews were once the second most numerous species of wading bird in North America Š numbering in the hundreds of thousands, possibly in the millions. Their destruction was so rapid that nesting and breeding areas were never fully documented. Only a few nests were found in arctic prairies of northwestern Canada between the Mackenzie and the Coppermine Rivers (Greenway 1967), but no one knew whether this was their prime nesting area. Their breeding behavior, number of eggs and chicks and related information remain undocumented.

Eskimo curlews flew in compact flocks and, when landing to rest and feed, were extremely tame and approachable. They were known to eat berries and Rocky Mountain grasshoppers (*Melanoplus spretus*) in burnt areas of prairie grass (BI 2000). This insect later became extinct, and prairies were plowed into agricultural fields (BI

2000). Eskimo curlews™ fall migration along the Atlantic coast through Labrador took them 8,000 miles to winter on the pampas of Argentina, southern Brazil and Chile (BI 2000). They were heavily hunted along the way. On one migration in 1872, three men in Cape Cod and Nantucket killed $300 worth of curlews they sold for 6 cents per bird [5,000 birds] to local meat markets (Hornocker 1913). In the spring, the birds would return through Central America and the Great Plains (Hayman *et al*. 1986). During the spring migration, they again became targets for the hunters. If a flock was shot at, the birds would fly only a short way before landing again, and they often returned to the same spot, resulting in the slaughter of entire flocks (Schreiber *et al*. 1989). The meat market hunters could fire a single shot that would bring down dozens of Eskimo curlews (Peck 1990). This hunting endangered them (Ehrlich *et al*. 1992) and, in spite of a ban on hunting in 1916, no recovery took place (BI 2000).

Their wintering habitat had been plowed as well, beginning in the late 19th century when their pampas in Argentina were used to produce export crops for Russia (Schreiber *et al*. 1989). Their populations plummeted from loss of habitat and unrestricted hunting, and fewer and fewer curlews managed to reach their northern breeding grounds. By the turn of the century, Eskimo curlews had become extremely rare. None has been seen in South America since 1939 (BI 2000). Several birds were shot in Barbados on their southern migration in 1964, and during the 1980s through 1996, various unconfirmed sightings were made (BI 2000). There is little hope that the Eskimo curlew survives.

Dominant among all the prairie predators, the grizzly bear (*Ursus arctos horribilis*) towered more than 10 feet tall when standing upright. Very common on the prairie, these bears ranged over most of western North America, from the Arctic Circle to northern Mexico. They were common in many types of grassland. All the subspecies except *Ursus arctos horribilis* became extinct south of Canada. In spite of its great strength and intelligence, in addition to the difficulty explorers and settlers had in killing it, these great bears were hunted to near extinction. Lacking cover in most of the Great Plains, the bears made large targets as they foraged for their primarily vegetarian diet, and were eliminated here first. Hunters made expeditions to kill these animals, and wrote articles and memoirs of their hunting prowess as they eliminated grizzly bears from one area after another. South of Alaska, only Yellowstone National Park and Glacier National Park harbored grizzly bears by the 1940s (Allen 1942).

Fur trapping intensified in the 19th century, with professional trappers combing the countryside, setting leghold traps and spreading poison to kill the most valuable furbearers such as beaver and river otter. Within a short time, both these animals had disappeared from large parts of the country, including most of the Midwest. The American beaver (*Castor canadensis*) is a keystone species in aquatic environments, creating habitat for otters and other wildlife with their dams. In fact, the range of the river otter in North America nearly coincides with that of the beaver. Trappers killed beavers in their lodges and dynamited dams to scare them into the open until these once common rodents became rare in many parts of the country. Their fur was highly valued and used in the manufacturing of top hats in England and Europe. The relentless trapping wiped these animals out throughout much of the country, and the beaver ponds that once dotted the landscape disappeared, greatly altering ecosystems for the worse. Otter fur was even more valuable because of its durability and waterproof qualities, and these animals, which had never been abundant, disappeared from two-thirds of their original range south of Canada (Nilsson 1985). River otters play an important role in aquatic ecosystems by culling overpopulated fish populations.

Other predators, such as the gray wolf, the kit (*Vulpes macrotis*) and the swift fox (*Vulpes velox*), were nearly eliminated from the United States south of Alaska. Fur trapping was followed by persecution in the form of predator control programs to benefit livestock ranchers. The gray wolves of the prairie were often white or pale gray and were entirely eliminated here (see Persecution and Hunting chapter).

The fleetest animal in North America nearly became extinct. The pronghorn (*Antilocapra americana*), a species found only on this continent, is not a typical antelope, but the last survivor of a family of ungulates long extinct. Once abundant throughout the Great Plains and in the deserts of the Southwest and Mexico, they may have numbered as many as 40 million animals prior to European settlement (Peters and Lovejoy 1990). Pronghorns travel in herds able to "fairly fly over the ground," in the words of Glover Allen (1942), when fleeing predators. Their natural curiosity,

an urge to investigate any unfamiliar object, may have contributed to their near•extinction. One hunter told of luring the pronghorns within gunshot by donning a white sheet and approaching them on all fours (Allen 1942). George Catlin painted natives luring them close by waving a feather on a stick.

By the turn of the century, so many pronghorn had been shot by settlers and meat hunters that the species was reduced to endangered status (Allen 1942). William T. Hornaday, director of the New York Zoological Park and a prominent conservationist who had saved the American bison from extinction in the early part of the century, predicted in 1913: "The Prong•horned Antelope, unique and wonderful, will be one of the first species of North American big game to become totally extinct. We may see this come to pass within twenty years. They cannot be bred in protection, save in very large fenced ranges. They are delicate, capricious and easily upset. They die . . . at the drop of a hat" (Hornaday 1913). Fortunately, his prediction did not come to pass, and total legal protection of the last pronghorns saved the species from extinction. Yellowstone National Park was crucial to the species' survival, and the bison™s as well, by protecting remnant herds. These herds provided the stock from which pronghorns were reintroduced to areas where they had been eliminated (Allen 1942). Today, they are fairly common in the western states of Montana, Wyoming and Colorado and found in smaller numbers in other parts of the West (see Grasslands, Shrublands and Deserts chapter for more on this species).

Another victim of the hunting slaughters of the 19th century was the Badlands bighorn sheep (*Ovis canadensis auduboni*), once numerous in the rugged hill country of the upper Missouri and Little Missouri Rivers in North and South Dakota and parts of Nebraska (Allen 1942). Weighing about 344 pounds, the males had massive curved horns that trophy hunters sought. While they grazed on the prairie near the high buttes, they were ambushed by hunters who cut off their escape. Even President Theodore Roosevelt contributed to their extinction by hunting them in the early 1880s (Allen 1942). The last record of this grayish brown sheep in North Dakota was an old ram killed about 1905, and the dates of extinction of the South Dakota and Nebraska populations are unknown (Allen 1942). Rocky Mountain bighorn sheep, another race of this species, have been reintroduced into the South Dakota Badlands.

Prairie streams and clear•flowing rivers provided habitat for several unique species of fish. The harelip sucker (*Lagochila laura*), whose downturned mouth had a large disk with which it fed on the stream bottoms, became extinct in 1893 when grasslands were plowed and streamsides disturbed; the water became turbid and muddy, causing the fish to literally asphyxiate in the silt•laden water (Day 1981).

Today, the tallgrass prairies have become wheat and corn fields, crisscrossed by highways, and dotted with towns and cities. More than 90 percent of the original prairies are gone (Peters and Lovejoy 1990). Even in the few areas where native grasses were not plowed under, diversity of grass species has declined from 200 to 30 species in most areas because of heavy livestock grazing (Peck 1990). Tallgrass prairie reserves have been established in Wisconsin, Kansas and Oklahoma. In the latter state, a herd of 300 bison was released in the early 1990s in virgin tallgrass prairie in Oklahoma by The Nature Conservancy after an absence of more than 100 years. Many National Grasslands were established in the range of the shortgrass prairie, primarily for livestock, but after many decades of grazing, rodent and predator control, this land bears little resemblance to the original prairie (see Grasslands, Shrublands and Deserts chapter).

Western Landscapes

In the southwestern United States and northern Mexico, deserts harbor a great wealth of species. The Mojave, Sonoran and Chihuahuan Deserts of the southwest differ from one another in their vegetation, topography and wildlife. All are dotted with deep springs and oases, each having endemic species of fish Œ vestiges from ancient

times when seas covered the land. The Sonoran Desert, most verdant of the three, is studded with giant Saguaro cacti (*Sereus giganteus*), more than 60 feet tall and found nowhere else on Earth, along with many other unique and beautiful desert plants. Deer, pronghorn, bighorn sheep and a variety of predators Š from grizzly bears and jaguars to gray wolves and coyotes Š lived in this desert, the most botanically rich in the world. Bird life was also prolific, and desert tortoises sheltered in burrows during the day. Mountain ranges jut from the Chihuahuan Desert to the south, and the Mojave of California is characterized by an extremely hot and arid climate, in which many unusual plants and animals manage to survive.

In southeastern Utah and Nevada, pinyon•juniper vegetation once covered thousands of square miles. The US Department of Interior's Bureau of Land Management has converted millions of acres into shrubland for the benefit of cattle. The pinyon pines, whose nuts have been a source of food for native tribes for thousands of years, have been destroyed in large part by chaining, wherein chains are stretched between two bulldozers, which then drag them across the pine-juniper bushes and trees, uprooting them. This ecosystem is home to desert tortoises and a wide variety of birds and small mammals, but today, the diversity and abundance of wildlife has been greatly diminished.

Much of the deserts are federally owned, and management has been primarily to benefit livestock owners and other users. Portions of the Mojave Desert and more than a million acres of spectacular Utah cliffs and desert have recently been made a National Reserve. These areas will not receive strict protection, however, since oil drilling and other activities, such as livestock grazing, will be allowed.

Streaming through the dry Southwest, the mighty Colorado River carved the vast Grand Canyon in Arizona as the land was thrust up and sunk with movements of the Earth over millions of years of geologic time. Some of the oldest rock formations have been dated at more than 1 billion years. These eons are etched in the Canyon's layered slopes. This canyon is one of the great natural wonders of the world, a wilderness of pastel-hued cliffs and beautiful vistas. Plateaus surrounding the canyon are geographically isolated, and many endemic animals inhabit these pine forests. In the Colorado River's turbid waters, a large number of unique fish evolved. The river has been dammed throughout its course, however, to supply water for irrigation, cities and suburban homes, as well as to generate electricity. One-fourth of the Colorado's water is used to irrigate the crops of California's Imperial Valley. The delta of this once immense river was described in 1922 by the conservationist Aldo Leopard as teeming with wildlife. That same year the Colorado River Pact was signed, which gradually removed its flow. Today the delta in northern Mexico is almost dry. The endemic fish and birds of the Colorado River system have been decimated by these projects. Some are being conserved under US Endangered Species Act programs conducted by the Fish and Wildlife Service. The dams that pepper the river turn the once warm and silty water cold and clear, a new habitat that native fish find intolerable.

The Sonoran Desert's unique and beautiful plant life has declined in the decades since 1970 because of unrestricted development for suburban housing; much of it is for retired persons seeking a dry and sunny climate. New houses, roads and commercial centers are gobbling up tens of thousands of acres, and in the process, the venerable giant Saguaros and other desert vegetation are bulldozed. These new communities use enormous amounts of water piped from the Colorado River and several diverted desert rivers. These desert oases turned to dust, eliminating their wildlife and plants. One of the few desert-nesting bald eagle populations became extinct as a result of the Central Arizona Project, which diverted water for agriculture and towns. Most residents in the Southwest have eliminated natural desert vegetation and planted grass lawns in front of their homes, which require almost constant watering and heavy use of chemical fertilizers, pesticides and herbicides Œ pollutants of the water table.

Merriam's elk (*Cervus canadensis merriami*) was native to various mountain ranges of southern Arizona and New Mexico. The antlers of this elk were the largest of all the elk races, and the animal was described as more pale and reddish than the Rocky Mountain elk (Allen 1942). Vulnerable because of its restricted range, it was hunted by cattle ranchers in the late 1800s, and crowded out by livestock. The last individuals were killed around 1906 in the Chiricahua Mountains of southeastern Arizona, where they had sought refuge in high altitudes (Allen 1942).

Thousands of elk and bighorn sheep died from diseases brought by domestic cattle. Lacking natural resistance,

entire populations died soon after they came into contact with domestic cattle and sheep that carried disease. Native Americans also died by the thousands because of diseases Œ from measles to small pox Œ brought by colonists and settlers. A number of tribes that had inhabited the West for thousands of years became extinct. In some cases, the tribes lost their land and dwindled to extinction.

West of the Rocky Mountains an unbelievably rich and beautiful land awaited settlers. The Sacramento and San Joaquin Rivers flow through the huge Central Valley, an area covering thousands of square miles. Prior to settlement, breathtaking vistas of wildflowers and grasslands grazed by innumerable elk and mule deer were framed by distant snowy mountains. The largest lake west of the Mississippi River, Lake Tulare, covered much of this river valley. Shallow and seasonal, this lake swelled after spring rains to serve as a breeding ground for an estimated 100 million waterfowl. Early naturalists spoke of the birds darkening the sky for days.

Spanish colonists established vast cattle ranches, beginning in the 1600s in what is now California. After Mexico lost this territory at the end of the Mexican War in 1848, American settlers poured into the region and agriculture began on a grand scale. In the late 1800s, California became thickly settled. The grasslands, deer, elk and the distinctive California grizzly bears that roamed California's valleys were eliminated by hunting and habitat destruction. The grizzly bears, still pictured on California's flag, were hunted to extinction (Nowak 1999). The Central Valley soon became California's bread basket, with agriculture displacing the tule elk (*Cervus canadensis nannodes*), whose range once extended throughout the San Joaquin and Sacramento Valleys, half the length of the state. As a result of hunting and loss of its habitat, the small herds of remaining elk became confined to a tule marsh area near Tulare Lake (Allen 1942). Transplants to other areas have not succeeded, and this subspecies remains very rare. Ninety•five percent of the wetlands of California's Central Valley and marshes that once dotted the coastline have been filled in for farms and development. Tulare Lake and its millions of ducks disappeared completely from drainage and water pumping, becoming the world's largest artificial farm, irrigated by water piped from elsewhere in the state. The Central Valley Project, an immense system of ditches, canals and pipelines, pumped water from the rivers in the Sierra Nevada Mountains to supply Los Angeles with water, devastating salmon and other wildlife. The Sacramento River once had an estimated 2 million salmon, and a fishery, but today they are nearly extinct as a result of the water diversion and dams.

California has incurred the greatest loss of wetlands of any state. Damming and diking of waterways to divert water for irrigation in the Central Valley resulted in the extinction of a foot•long fish once caught for the fish markets of San Francisco. The thicktail chub (*Gila crassicauda*) was very common until the 1880s, but by the 1920s, it had been driven to extinction (Day 1981). San Francisco Bay, the largest wetland and estuary on the West Coast, has been greatly altered by water diversion projects and drainage for agriculture and building. The bay has a great number of endemic species and races of birds and fish, and many of these have disappeared or become extremely rare. Federal protection under the US Endangered Species Act for many of these species may prevent their extinction.

North America's largest bird, the California condor (*Gymnogyps californianus*), soared over coasts and inland valleys Œ as far north as Washington State. This bird came close to extinction as a result of hunting and accidental poisoning (see Persecution and Hunting chapter). The last wild birds were captured for captive breeding, and young birds have been released to the wild. It will be years before it is known whether this giant vulture will survive and breed in the wild. In the foothills of the Sierras grew thousands of immense sequoias (*Sequoia gigantea*), trees that can live for more than 4,000 years. At a height of up to 300 feet tall, these trees attain a girth of 100 feet and support wood weighing 600 tons, making them the most massive and heaviest organisms that have ever lived (Jonas 1993). Sequoias take 3,000 years to attain full growth, sprouting from a seed only a quarter inch long. These trees were logged, reducing them greatly until they received legal protection. Sequoia National Forest was declared a National Monument by President Bill Clinton in 2000 to stop logging of other types of trees in the forest, which was threatening the root systems and survival of these ancient Sequoias. It is now illegal to cut a Sequoia.

In northern California, Oregon and Washington, ancient forests of hemlocks, pines, cedars and coast redwoods (*Sequoia sempervirens*) had grown undisturbed for thousands of years. Redwoods are the tallest trees on Earth,

reaching heights of more than 365 feet and measuring up to 58 feet in circumference (Jonas 1993). These forests once lined 2,000 miles of Pacific coastal region from northern California through British Columbia, ending in southeastern Alaska, covering 70 thousand square miles. Centuries of logging have reduced these forests to only about 5 percent of their former size in the United States, and less than 40 percent in Canada (Middleton 1992). Commercial logging began in the 19th century and has proceeded throughout this century, clear cutting millions of acres of redwoods, Douglas Fir and other evergreens in forests, cutting in a few hours trees that took a thousand or more years to grow. Once cut, these forests need hundreds Š if not thousands Š of years to regenerate to their former biological richness. The land where these forests once stood has been converted to other uses, precluding their regrowth.
Loggers are still fighting conservationists over the fate of the last five percent of Pacific Northwest old-growth forests and their endangered residents (see Forests chapter). Although the sequoias and coast redwoods have escaped extinction, they are far rarer than they once were, and the redwoods continue to be cut to be made into lawn furniture and decks.

A race of bison native to these forests, the Oregon bison (*Bison bison oregonus*), was distinct in being slightly larger than the Plains bison, with longer and straighter horns (Allen 1942). Once native to southern Idaho, northern Nevada to southeastern Oregon and northeastern California, they died out soon after the arrival of the early explorers. Although the history is unclear, tales from the Native Americans indicate that arms supplied to them by explorers were used to hunt these animals to extinction by the mid•1800s (Allen 1942).

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Wetland Drainage: Page 2

Thousands of years of drainage, pollution, diversion and overuse of the rivers and wetlands in the Middle East have destroyed once verdant areas such as the site of ancient Babylon in present-day Iraq. The single exception, until recently, was the 6,000-square-mile delta of reeds, lagoons and marsh south of the confluence of the Tigris and Euphrates Rivers on the Persian Gulf in Iraq. This wilderness maze was inhabited by the reed homes of the Shiite marsh Arabs (Hedges 1993). They fished from small boats woven from marsh plants, a lifestyle unchanged for thousands of years (Dugan 1993). After the 1989 Persian Gulf War, Iraq's President Saddam Hussein ordered that the swamps be drained to vanquish the Shiites, who had opposed his government (Hedges 1993, Lewis 1993). The Iraqi portion of these marshes has also been polluted by oil spillage from the war. Within a few years, approximately 90 percent of these ancient wetlands were drained and soon dried out in the desert sun. Observers flying in small aircraft have documented that these wetlands now resemble dusty fields.

The best known animal resident of Iraq's marshes may be Maxwell's otter (*Lutra perspicillata maxwellii*), named for the charming otter who inspired the story *Ring of Bright Water*, by Gavin Maxwell (1961). This male otter had been captured in these marshes and brought by the author to the British Isles after many misadventures in trains and hotel rooms. When examined by zoologists, he was determined to be an endemic and distinct race of the smooth-coated otter. The fate of Maxwell's otters may not be learned for many years to come. Other victims of the destruction of Mesopotamian marshes may be the birdlife: several million waterfowl wintered in the wetland (BI 1993). Endangered and rare birds that winter here include the dalmatian pelican, pygmy cormorant (*Phalacrocorax*

pygmaeus), marbled teal (*Marmaronetta angustirostris*), white-tailed eagle (*Haliaeetus albicilla*), imperial eagle (Aquila heliaca) and slender-billed curlew (*Numenius tenuirostris*), according to BirdLife International (1993). Two endemic breeding birds are also at great risk. The Iraq babbler (*Turdoides altirostis*) and the Basra reed warbler (*Acrocephalus griseldis*) are restricted to these marshes in southeastern Iraq and adjoining southwestern Iran. The latter bird is listed as near-threatened in *Threatened Birds of the World* (BI 2000). Although no status surveys have been made in the breeding range of the Basra reed warbler, the number of these birds seen in wintering habitat in Kenya has declined in recent years (BI 2000). A small portion of these marshes remains in adjoining Iran, but it cannot support a fraction of the wildlife that inhabited the Iraqi marshlands.

The worst oil spill in history took place in the Persian Gulf as Iraqi President Saddam Hussein, enraged at losing the war with Kuwait, opened and set afire that country's oil wells to spill 500 million gallons of oil into the delicate Gulf (Earle 1995). This represented 45 times the amount released by the *Exxon Valdez*. It added to the 250,000 barrels of oil released into the Persian Gulf every year for the past decade. The 1991 spill killed cormorants and other sea birds, sea turtles and dugongs. The fires belched toxic chemicals into the air and water in thick black clouds that darkened the sky at noon. Every plant and animal within many miles became coated with black soot. Marine scientist Sylvia Earle witnessed a bird in the midst of this hellish landscape as it swooped into a pool of oil, lured by a struggling dragonfly. "The bird barely moved, succumbing at once to shock, the slimy embrace gluing feathers, clogging nostrils, searing bright eyes, snuffing life" (Earle 1995). The 400-mile coastline of Kuwait, an expanse of marshes and mangroves, became covered in thick black oil, leaving only a few areas of untouched beaches protected by a causeway (Earle 1995). Tens of thousands of migrating shorebirds died in this oil along with a host of invertebrates and fish, and since much of the oil sank and attached itself to sand and mud, the oil killed for many years (Earle 1995). The most common coral in the Persian Gulf, staghorn, released eggs that were killed by the oil, and most of the adult coral in the region of the spill died or bleached (Earle 1995).

Geography-Draft

1600 to present					
	Number of Species Extinct				
Islands	**Birds**	**Mammals**	**Reptiles**	**Amphibians**	**Total**
Atlantic Islands					
Ascension I.	1				1
Canary Is.	1		1		2
Cape Verde Is.			1		1
Falkland Islands		1			1
Gull Island (Off NY, USA)		1			1
Iceland, Funt I. (Canada)	1				1
St. Helena	7				7
Subtotals	10	2	2		14
Caribbean					
Barbuda		2			2
Barbados		1			1
Bahamas	1				1

Caribbean region	2	1			3
Cayman Is.	1	1			2
Cuba	1	7			8
Guadeloupe	2		1		3
Hispaniola (Haiti & Domnican Republic)	1	15			16
Jamaica	4	2	2		8
Martinique	1	2	3		6
Navassa I.			1		1
Puerto Rico		6			6
St Croix (Virgin Is.)			1		1
St Lucia		2	1		3
St Vincent		1			1
Subtotals	13	40	9		62
Indian Ocean Islands					
Amsterdam Island	1				1
Christmas Island		3			3
Madagascar	2	1			3
Mascarene Is.	31	1	13		45
Seychelles	2		1		3
Subtotals	36	5	14		55
Mediterranean					
Sardinia		1			1
Subtotal		1			1
Pacific Islands					
Auckland I.	1				1
Bering I. region	1	1			2
Bonin Is.	3	1			4
Caroline Is.	3				3
Chatham Is.	5				5
Fiji Is.					1
Galapagos Is.		7	1		7
Guadalupe I.	2				2
Guam	1	1			2
Hawaiian Is.	21				21
Lord Howe & Norfolk Is.	6				6
Kangaroo I. (Australia)	1				1

Marquesas	1				1
New Caledonia	4				4
New Zealand	14	1	1		16
Okinawa		1			1
Pacific region	1				1
Palau		1			1
Philippines		3			3
Ryukyu Is.	1				1
Samoan Is.	1				1
Santa Cruz Is.		1			1
Society Is.	7				7
Solomon Is.	1				1
Tonga Is.	1				1
Vanuatu	1				1
Wake I.	1				1
Subtotal	77	17	2		96
Asia					
Indonesia	1				1
Subtotal	1				1
Island Totals	137	65	27		229
Mainlands					
Africa		5	1		6
Asia	2	1			3
Australia	2	22			24
Europe & Near East		2		1	3
Mexico & Central America	3	4		4	11
North America	3	1		1	5
South America	10				10
Mainland Totals	20	35	1	6	62

Source: Table of Extinct Species in the Appendix of this book. Sources of information are listed with the table.

Note: See the Appendix for the list of these species in chronological order, and the references that describe these animals and their extinctions, as well as those that include illustrations of the extinct species.

The following account chronicles some of the many extinctions and destructions of natural ecosystems that have taken place in North America over the past few hundred years. Great biological treasures have been stolen from future generations, and the processes by which they were lost are typical of those occurring elsewhere in the world. The sudden loss of the most abundant and prominent wildlife species of the continent created a profound shock in the

public early in the century that set the stage for today's conservation and humane programs. This concern may turn the tide for species that could suffer the fate of the passenger pigeon (*Ectopistes migratorius*) and others, but unless public opinion is better translated into public policy regarding the land and wildlife, further losses will occur and the lessons that might have been learned will be ignored. A strong and pragmatic commitment to preserve what remains of the natural world on the continent, based on a realization that our fate is linked to nature's fate, is essential to prevent further extinctions.

It's Too Late

Introduction

Skeptics ask why it should matter whether the tiger (*Panthera tigris*) or other endangered species become extinct. Aren't all extinctions natural events? Yet enormous differences exist between the extinctions of the dinosaurs and other animals that faded out eons ago and those of recently disappeared species. Dinosaurs proliferated into a great diversity of species and dominated other life over a period of many years. Some dinosaur families endured tens of millions of years on Earth Œ others far less Œ before fading into extinction. It is difficult to grasp the reality of their immense sojourn, as some species existed for only a hundred thousand years. The Ornithischia, one major group of dinosaurs, had an enormous number of living species 135 million years ago at the dawn of the Cretaceous Period, but slowly died out over the next 60 million years. The last of the line became extinct some 65 million years ago as the last of the dinosaurs expired.

Extinctions of dinosaurs and millions of other species that disappeared from Earth at that time were natural in origin. These extinctions had many causes; changes in climate resulting from meteors colliding with Earth may have killed off the last dinosaurs. Many scientists believe the impact raised a dust cloud that blocked sunlight and reduced the enormous amounts of vegetation needed by the dinosaurs, and it may have cooled the climate as well. Another major cause of ancient extinctions was the movement of the Earth's tectonic plates, which broke up huge land masses into smaller ones. Some species became isolated on islands too small for their habitat requirements, and stronger species caused the extinctions of weaker or less adaptable species when continents were joined. Continents and islands moved into different climate zones as well. The Earth's climate and atmosphere have undergone major changes over the ages and species that could not adapt have fallen into extinction. Volcanic eruptions have spurred extinctions by inundating land with lava and cooling the climate with dust. Islands produced by volcanic eruptions have risen from ocean bottoms, become covered with vegetation and home to unique wildlife, only to sink into the sea some time later.

In the past, ecological roles left empty by extinctions were soon filled by the evolution of new species. After the last of the dinosaurs died out some 65 million years ago, mammals and other animals proliferated on Earth. The overall diversity of species remained stable or increased. At present, however, diversity of life on Earth is in steep decline as species are dying out without being replaced.

The Recent Picture: A Rapid Rise in Extinctions

The current extinction rate is estimated to be up to a thousand times higher than prehistory rates (Leakey and Lewin 1995, Stearns and Stearns 1999). This phenomenon has been described as the sixth wave of extinctions by scientists Richard Leakey and Roger Lewin Œ ecosystems are being disrupted around the world, and the wondrous tapestry of living things that supports human existence is unraveling.

Since 1500, approximately 375 species of invertebrates, 81 species of fish (Hilton-Taylor 2000) and 291 species of mammals, birds, reptiles and amphibians (see Appendix) have become extinct. About three-fourths of vertebrates other than fish have disappeared since 1800, while only 80 species died out in the previous three centuries. These figures represent a minimum number. An estimated 5 million species of animals and plants exist in tropical rainforests, a conservative figure that may apply to insects alone, according to biologist Edward O. Wilson (1988). About half of these species are restricted or localized in distribution (Wilson 1988). With this in mind, at the present rate of destruction of tropical forests, some 17,500 species are being lost per year Œ a rate 1,000 to 10,000 times greater than extinction rates prior to human intervention (Wilson 1988).

Human activity lies at the root of this potentially catastrophic phenomenon. Killing for food or sport, as well as conditions created by humans, such as habitat destruction and competition, predation and disease from introduced animals, is responsible for the vast majority of these extinctions. It is with this perspective that we can see the present situation as an *unnatural* event, not linked to climatic changes, meteors or volcanic eruptions, but a result of human-caused changes wrought in the Earth's environments and by direct extermination.

Plants

Extinctions of plants and trees can have a direct impact on human society. A sap found in 1997 by Dr. John Burley, research director of Harvard University's Arnold Arboretum, was tested by the National Cancer Institute and determined to be 100 percent effective in preventing cell replication of the AIDS virus (Stocker 1996). The plant sample came from an ancient swamp forest tree in Sarawak, a Malaysian state on the island of Borneo. When Dr. Burley returned to the spot a year later for another specimen from the tree, only a stump remained, and no other trees of the same species could be found (Stocker 1996). The substance is being reproduced synthetically, but it is not known whether it will be as effective as the original compound (Stocker 1996).

Sarawak's forests grew undisturbed for 180 million years, but they are now rapidly disappearing along with the rest of Borneo's ancient forests. Commercial loggers have felled tens of thousands of these old growth, towering trees in Indonesia and other tropical rainforests for the manufacture of disposable packing crates and chopsticks for Japanese and Chinese markets. Borneo's forests are also being consumed by fires set by wealthy landowners to clear land for palm plantations, or by settlers for farmland, eliminating an untold number of plants. Some tropical tree species have wide distributions over thousands of square miles, but many occupy extremely small areas. This was dramatically illustrated in the disappearance of this tree. Thousands of compounds that could cure diseases or be of great economic and ecological importance may be lost on a daily basis as the world's forests are destroyed at this unprecedented rate.

Plant extinctions have accelerated in the past few centuries. An estimated 5,050 taxa of plants, including species, varieties and other taxonomic groups, have become extinct worldwide since 1700, according to Ghillean T. Prance of the Royal Botanical Gardens Kew (Prance 1990). This implies at least 17 plants have been lost per year since 1700. Yet however high this rate appears to be, it is probably a low estimate. A 1998 study by botanists Kerry S. Walter and Harriet J. Gillett for the International Union for the Conservation of Nature (IUCN) found that 380 species, a number that does not include varieties and other taxa, have recently become extinct. These authors admit their extinction total may be low as a result of lack of data, and they did not define the time period covered.

· The data lacks exact numbers of plant extinctions. Plants rarely leave signs of their existence as vertebrates do, since bones are the basis of much data on animal extinctions. Non-woody plants, which make up the majority of plants, leave little trace when they die, and are soon consumed by microbes. This is especially true in tropical areas, where plant matter is consumed very quickly. We know of ancient plants by chance events, such as the preservation of pollen grains or other plant parts in peat, mud, amber or fossilized stone. When numbers of plant extinctions are estimated, the diversity and status of habitat are important considerations. Moreover, only a small percentage of all plants have been scientifically described. What is known is a great many regions of the Earth that once had very diverse endemic plants have been destroyed within the past few centuries, and a majority was not thoroughly assessed.

Botanical wealth is often discovered and destroyed soon after. In Ecuador's mountain ridges, botanists Al Gentry and Calaway Dodson of the Missouri Botanical Garden in St. Louis discovered many unique plants in 1978 on a crest known as Centinela Ridge in a 20 square kilometer cloud forest in the foothills of the Andes. Among the plants were 38 endemic species, many of which were unusually dark•leafed (Forsyth 1990). The two scientists found a total of 90 related plants growing under the forest canopy with epiphytic plants, such as bromeliads and orchids, on the trunks and branches of the trees (Wilson 1992). These cloud forests and paramos Œ treeless, mossy areas in the northern Andes Œ are centers for unique species. At the time they discovered the plants, Gentry and Dodson observed farmers from the valley below clearing the forests, as they have done on 96 percent of the Pacific ridges of the Andes (Wilson 1992). Gradually, the clearing moved up to Centinela Ridge. By 1986, the botanical oasis had disappeared; in its place were cacao and other crops (Wilson 1992). These lost species might have provided compounds to treat cancers, or been an ancestor of an agricultural plant, such as a perennial tomato, but they exist now only as pressed specimens taken by the botanists.

Near Centinela Ridge is Rio Palenque; once an extensive cloud forest, it is now diminished. It was among the most botanically diverse forests in the world Š 600 species per square kilometer (Forsyth 1990). Ornithologists and birdwatchers came from all over to see the 336 bird species of Palenque's diverse habitats (Forsyth 1990). The endangered harpy eagle was one spectacular native bird that disappeared when the forest was cleared (Forsyth 1990).

Cloud forests are found in tropical Asia, Africa and Latin America. These ecosystems shelter such rarities as the iridescent green and red resplendent quetzal of Central America, but this ecosystem has nearly disappeared. An impressive variety of orchids, mosses and dwarf trees grow in these misty, cool environments. Should global warming continue, cloud forests will be among the first type of forest to disappear altogether, extinguishing thousands of unique life forms in the process.

Introduction of alien species of plants can overwhelm native species and cause their extinction (Prance 1990). In Indonesia, a type of non-native grass called imperata (*Imperata cylindrica*) grows aggressively in deforested areas, spreading into forests. Once established, imperata obstructs the regeneration of native plants and trees (Prance 1990), many of which exist nowhere else. Imperata has also displaced endemic plants in other parts of the world. In Australia, exotic plants are a major factor; they have eliminated at least 117 plant taxa and endangered another 1,931 (Prance 1990). Ironically, native Australian plants have caused extinctions after they became established in parts of South Africa and the Florida Everglades.

Plants have also disappeared as a result of pollution in the form of acid rain caused by power plant emissions, heavy metal (especially lead) accumulations and other toxins in the air (Prance 1990). Forests in North America and Eurasia have been susceptible to pollution, and in some areas, all forms of vegetation have died out.

Livestock overgrazing is responsible for the extinctions of countless plants, and endemic island species are among the most vulnerable. Such plants may occupy only a few acres. The South Atlantic island of St. Helena lost at least 10 kinds of endemic trees after the introduction of goats onto the island in 1513; the St. Helena redwood (*Trochetia erythroxylon*) became reduced to a single tree in the wild (Prance 1990). Fortunately, it was saved by propagation at the Royal Botanic Gardens Kew in London and cultivated specimens have been reintroduced (Prance 1990). The

sandalo (*Drypetes caustica*), a fragrant type of sandalwood tree that once grew abundantly on the island of Juan Fernandez, the site of *Robinson Crusoe*, became extinct by 1916 after centuries of heavy logging and destruction of seedlings by goats (Prance 1990).

The Mascarene Islands, east of Madagascar in the southern Indian Ocean, have been the scene of many plant extinctions. One of the three main islands, Mauritius, was home to the famous dodo. Ebony once covered the plains and mountain slopes of this island, but during colonization of the islands from the early 17th century onward by Holland, France and Britain, extraction of a huge volume of timber denuded valleys and all accessible places (Parnell *et al.* 1986). As early as 1671, Mauritius had appointed a chief woodcutter to oversee the cutting of the island's forests. Unfortunately, this had little effect on forest clearance. Of the dense tropical evergreen forests that once covered the lowlands, only a few patches remain in inaccessible areas. Trees 20 meters or more in height grew in the uplands of the island, their branches heavy with thick growths of lianas and orchids. On the ground, ferns and mosses sprung up luxuriantly.

Today, only a single tract remains of this habitat, the Black River Gorges reserve (Sayer *et al*. 1992). By 1874, these islands, once described as verdant "earthly paradises," were dry and comparatively barren, with a vegetation composed mainly of weeds (Parnell *et al*. 1986). Only about 30 square kilometers of Mauritius forest survives since 93 percent was destroyed (Sayer *et al*. 1992). The mangrove forests that once lined Mauritius' shores have disappeared along the West Coast because they were cut for firewood. Rodrigues, a small island off the coast of Mauritius that was once a wildlife haven, lost virtually all its forests. Reunion, the third island, was also settled and heavily logged. About 61 percent of its forests, including virtually all its lowland forests, have been cleared; only 100 square kilometers remain (Sayer *et al*. 1992). A few remnants of montane forest have been protected by the French government, which controls the island.

Mauritius, Rodrigues and Reunion have lost many native plant species. Of 1,296 native plants, 53 species are extinct and 393 of the surviving species are threatened, according to the *1997 IUCN Red List of Threatened Plants* (Walter and Gillett 1998). Little remains of its ebony forests, and eight ebony tree species are virtually extinct (Simon 1995). The islands have lost six of their beautiful orchid species, and 13 more are threatened (Walter and Gillett 1998). Mauritius and Rodrigues have been described as the "Islands of the Living Dead" by authors Beverly and Stephen Stearns because at least 30 plant species have ceased reproducing in the wild, living on the edge of extinction (Stearns and Stearns 1999). One, *Ramosmania heterophylla*, described in 1874, was not seen again until 1982 when botanist Wendy Strahm found the last specimen growing by a roadside. She fenced it off to protect it, only to learn this made local people consider it a "magic plant" that cured all diseases and maladies (Stearns and Stearns 1999). They cut off small pieces Š despite its fencing Š and have nearly obliterated it. Luckily Strahm took cuttings and sent one to Kew Gardens in England for propagation; it now grows there, but does not seed because the plant is defective (Stearns and Stearns 1999). A critically endangered tree, *Elaeocarpus bojeri*, native to Mauritius, has delicate, bell-like flowers with a scalloped fringe. Strahm's photograph illustrating these flowers appears on the cover of the *1997 IUCN Red List of Threatened Plants* (Walter and Gillett 1998). It epitomizes the status of many Mascarene plants in need of dramatic rescue programs, as well as the need to prevent extinctions, such as that of a rare Rodrigues tree hibiscus (*Hibiscus liliflorus*); the species became extinct in 1982 after it was reduced to a single plant growing on the top of a mountain (Stearns and Stearns 1999).

Two endangered native wild coffee plants of Mauritius (*Coffea macrocarpa* and *Coffea myrtifolia*) might invigorate domestic species stricken with disease if they are protected from extinction, illustrating another reason to preserve native plants. The wild ancestors of domestic grains and crops retain many characteristics lost in cultivated varieties, such as resistance to drought, insects and disease. An outbreak of cornleaf blight in the United States in 1970 cost farmers almost $1 billion, and the disease was not halted until a wild corn species was interbred with the domestic strain (Fenyvesi 1995). A perennial variety of maize (wild corn) found in a Mexican forest could be hybridized with domestic corn to save farmers from replanting each year. Other crops saved by crossbreeding with tropical forest wild stock include sugarcane, coffee, cocoa and banana (Schreiber *et al*. 1989). Yet with the accelerating rate of plant extinctions and destruction of native plant ecosystems, many such ancestor species may be

lost.

All ecosystems are plant-based. Plants produce oxygen, making life on Earth possible, and perform a vital task for other life forms by absorbing vast amounts of toxins and carbon dioxide. They are the source of thousands of important medicines, and discoveries of new medicinal uses of plants are being made on a regular basis. Disappearance of individual species of plants can impoverish or even collapse entire ecosystems when they are key to the survival of many species of animals or form an intrinsic link in an ecosystem.

Not only do many plants fade to extinction undocumented by botanists, but only a small percentage of living plants have been scientifically described. Botanists have identified more than 250 thousand types of living plants other than algae, fungi and bacteria, but most scientists agree these represent perhaps a tenth of all living plants. Almost 10 percent of surviving species are considered threatened with extinction. Some 34 thousand plant species are listed in the *1997 IUCN Red List* (Walter and Gillett 1998). Many of these plants have not been seen for years and may be declared extinct in the near future, or are clinging to life with only a few individuals left. Preservation of the planet's great diversity of plants to prevent further extinctions should be a priority of the first order.

Invertebrates

Invertebrates are key members of many ecosystems. Insects pollinate plants, while mollusks and gastropods form the basis of many aquatic food chains. Documentation of invertebrate extinctions is incomplete, but a minimum of 375 species (approximately eight crustaceans, 72 insects, 31 bivalves and 260 gastropods, snails and related species) have become extinct worldwide in the past few hundred years, according to the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000). Massive destruction of many habitats, especially islands with endemic species such as land snails, has eliminated hundreds of these creatures.

Extinct bivalves include mollusks native to the southeastern United States, the world's center of diversity for freshwater mussels. Dam construction turned clear, fast-flowing rivers into still ponds, destroying prime mussel habitat. Channelization, in which the natural curves of a river are straightened and its surrounding vegetation bulldozed from its banks, wreaked havoc in aquatic ecosystems. Biologically rich rivers became muddy, sterile ditches. These government-sponsored anti-flood programs took place during the first half of the 20th century, causing numerous extinctions of mussels and crayfish.

At the time, few people lamented the disappearance of these mussels, some of which were the size of dinner plates. They grew in huge masses on river bottoms, serving as keystone species in river ecosystems by providing habitats for fish, crayfish and huge river snails. Birds and aquatic mammals fed on the fish and other aquatic wildlife produced by these mussels; these large bivalves also cleansed the water with their filtering gills. Water pollution from industry and coal mining and sedimentation from logging have contributed to their extinction. Additionally, mussels are over-harvested because of their commercial value in the cultured pearl industry Œ their shells are harvested and broken into tiny pieces that are inserted into living oysters to stimulate the growth of pearls. These combined threats have pushed many species to extinction and others to endangered status. Their demise has caused species dependent on mussels for reproduction and habitat to disappear as well.

Scores of colorful endemic land snail species have died out in the Hawaiian Islands, other Polynesian and Indian Ocean islands and various southern Atlantic Ocean islands. These snails were once prolific in native forests, but naturalists and shell collectors took many thousands of them during the 19th century Œ until the 1920s, when it became too difficult to find them (Stearns and Stearns 1999). One individual, J.T. Gulick, the son of Hawaiian missionaries, "ransacked" the islands for tens of thousands of these colorful land snails, collecting 44,500 in three

years (Stearns and Stearns 1999). He alone caused the extinction of numerous species on the islands by encouraging rural residents to collect for him and by buying shells by the thousands, believing himself to be an important naturalist. He was among the collectors who scoured the woods where these shells clung to trees and low bushes by the hundreds (Stearns and Stearns 1999). Many were striped, while others were solid shades of ivory, yellow-gold and deep brown. Some collections were of no scientific value because the locations where they were obtained were not noted. No similar species remain in the wild today (Stearns and Stearns 1999).

In more recent times, exotic species of snails have been introduced onto islands for various purposes, preying on the native species. One expert estimated that when Captain Cook arrived in Hawaii in 1778, there were between 800 and 1,000 species of endemic Hawaiian snails from 11 families, but at present, only about 200 remain (Stearns and Stearns 1999). Recent extinctions have been caused by deforestation and predation by exotic snails, including the giant African snail, introduced by the Hawaii Department of Agriculture to prey on another exotic snail. Native snails feed mainly in endemic Hawaiian trees, another reason they have failed to adapt to the introduction of exotic trees and bushes. Unusual among invertebrates, these snails reproduce slowly, one species needing 19 years just to replace itself (Stearns and Stearns 1999). At least 49 species have become extinct in recent times, according to the Nature Conservancy's book, *Precious Heritage: the Status of Biodiversity in the United States* (Stein *et al*. 2000). The remaining species of Hawaiian land snail are endangered, and species are disappearing regularly from the wild, preyed on by exotic snails or rats and losing their host trees to logging (Stearns and Stearns 1999). Conservation programs have not been well-funded, as these are among the least well-known of Hawaiian wildlife.

On the island of Moorea in the Society Islands, the giant African snail was introduced as a food source, but when it became overpopulated, a carnivorous snail, *Euglandia rosea*, was introduced to prey on it. Instead, the latter species preyed voraciously on native tree snails, exterminating all 11 species; it is now in the process of eliminating the native snails of Tahiti (Wilson 1992).

Butterfly populations have declined from loss of host plants, pesticide use, over-collecting and loss of species upon which they depend. The Xerces Blue (*Glaucopsyche xerces*) is the only native species in the United States to have become extinct in recent times. It disappeared in the early 1940s, and the Xerces Society, dedicated to preserving butterflies, was named after it. It is one of 38 butterfly species that recently disappeared around the world (Baillie and Groombridge 1996).

Invertebrates play key roles in many of the world's ecosystems as food sources, for people as well as animals. Some, such as coral and mollusks, create habitats for thousands of species. Butterflies, mollusks and snails are among the planet's most beautiful creatures, yet conservation programs often neglect these important species.

Vertebrates

Vertebrate extinctions worldwide since 1500 total at least 372 species of mammals, birds, reptiles, amphibians and fish. The largest number Œ 157 species Œ were birds, while 100 mammal species, 28 reptile species, 6 amphibians and 81 fish species disappeared. The number and rate of extinctions have increased gradually in recent centuries, as the table "Extinct Species of Birds, Mammals, Reptiles and Amphibians" illustrates. Fewer than 80 of these vertebrates became extinct from 1500 through the 18th century, while in only the 19th century, 98 species of birds, mammals and reptiles died off. The rate accelerated during the 20th century; based on incomplete information, at least 115 vertebrates Š already 17 species more than in the past century Š were lost. (See Appendix for list of species and their dates of extinctions.) This total will be far greater when the toll for the 20th century is finalized.

229 species, almost 80 percent of the 291 extinct mammals, birds, reptiles and amphibians, were native to islands,

mostly located far from the nearest land mass, such as the Hawaiian Islands, Mascarene Islands and New Zealand. (See Table fiThe Geography of Extinction.fl) Many of these island species were distinctive and unusual, the products of thousands and even millions of years of evolution in isolation. Few left close relatives.

Some islands are fragments of ancient continents, broken off more than 100 million years ago, with resident wildlife and plants. New Zealand, Madagascar, the Seychelles and the larger islands of the Caribbean are examples of this phenomenon. In exceptional circumstances, original inhabitants survived; some evolved into different forms, while others remained almost unchanged. Additional plants and animals arrived by air, ocean current or clinging to masses of vegetation or floating logs, perhaps every thousand years. Few of these survived, but occasionally these new colonists were able to adapt to the new environment and thrive. Other islands were formed by volcanic eruptions or coral reefs growing atop extinct volcanoes. Virtually all native fauna and flora of these islands, which include the Hawaiian, Mascarene and Galapagos Islands, were colonizers. The majority of extinct island species were flightless birds, tortoises and other species unable to flee when European ships and their crews arrived in search of commodities such as spices, timber and fur animals. They were killed for food and sometimes found their habitats destroyed by logging or the many species of animals brought to the islands. They were successful species in adapting to their environment and surviving for long periods, even radiating into entire new families of animals, but nothing had prepared them for the drastic changes humans caused, or the high mortality from hunting or persecution.

Sixty-two mammals, birds, reptiles and amphibians, as well as all but one of 81 species of fish, were native to mainland areas. The continent with the largest number of non-fish extinctions is Australia, with 24 species, 22 of which were mammals, killed off by introduced animals and loss of habitat (see Mammals section in the table: fiThe Geography of Extinctionfl). Non-native species caused the extinctions of many fish in the United States, Mexico and Africa. Killing by persecution or commercial purposes, such as for furs, meat or sport, caused extinctions in Africa, North America, Australia, Europe and Asia. Capture for pets and killing eliminated birds in the Caribbean, Australia and South America. The clearing of forests eliminated a number of tropical birds in Asia and South America. Elimination of wetland habitats was the major cause of the extinction of amphibians and fish, especially those that were ecologically isolated, such as cave fish or desert spring species.

Extinct Species of Birds, Mammals, Reptiles and Amphibians
1500 to present

100-Year Periods	Mammals	Birds	Reptiles	Amphibians	Total
1500-1599	0	6	0	0	6
1600-1699	14	15	3	0	32
1700-1799	13	26	3	0	42
1800-1899	31	56	10	0	97
1900-2000	42	54	12	6	114
TOTALS	100	157	28	6	291

Source: List of Extinct Species in the Appendix of this book.

Fish Extinctions

The *2000 IUCN Red List* lists a total of 81 species of fish that have become extinct over the past 400 years. In addition, a large number of fish have been extinguished in Central and South American lakes Œ scientists are still compiling information. About 20 percent of the world's freshwater fish are indeed either extinct or in steep decline (Wilson 1992).

No version of the *IUCN Red List* has listed many species reported as apparently extinct by biologists around the world. In peninsular Malaysia, where 266 freshwater species were known to exist, a search found only 122 (Wilson 1992). In the Philippines, where massive environmental destruction has taken place, Lake Lanao on Mindanao is famous for its diversity of endemic cyprinid fish. Yet out of 18 species of three genera, an investigation found only three species of one genus (Wilson 1992). These extinctions were apparently caused by overfishing and competition from introduced species (Wilson 1992).

During this century, several mass extinctions of endemic fish have taken place when the creatures™ sole habitat was destroyed. Lakes in East Africa, the Americas and Russia have either been drained Œ as in the Russia™s Aral Sea Œ or native species have been crowded out or preyed upon by introduced exotic fish.

Africa's Great Rift Valley, a product of movement in the Earth's crust eons ago, is home to several lakes of great biological diversity. Lake Tanganyika has more than 140 endemic species of fish, Lake Victoria has more than 200 and Lake Malawi has at least 500 (McNeeley *et al*. 1990). These three lakes, home to hundreds of members of the colorful cichlid family, rank three, two and one respectively in the world for their diversity of fish (Myers 1979). The lakes have been separated for millions of years, and although Lake Malawi and Lake Tanganyika are only 320 kilometers apart, they have not a single cichlid fish species in common (Myers 1979). Each of these three lakes empties into great rivers; Lake Tanganyika flows into the Zaire, Lake Victoria into the Nile and Lake Malawi into the Zambezi (Kingdon 1989). Most ancient is Lake Tanganyika, 3 to 6 million-years-old and twice the age of Lake Malawi, which is half as old as Lake Victoria (Kingdon 1989). Lake Tanganyika is the second deepest lake in the world at 1,500 meters; only Siberia's Lake Baikal is deeper (Kingdon 1989).

Lake Victoria is a shallow, enormous lake, covering an area the size of Ireland or the state of Maine (Kingdon 1989). Evolution of cichlid fish in these lakes over the ages produced an extremely rich fauna. From a few ancestor species, these fish flourished into an extraordinary diversity, each species filling a different ecological niche. Their diets are extremely varied and may include plankton, crustaceans, mollusks or fish eggs (larvae) and even other fish (Kingdon 1989). Cichlids brood their eggs in their mouths Œ up to a thousand at a time Œ protecting them from their many natural enemies. They exhibit a great range in color, including silver, sapphire and turquoise blue, orange and yellow, and they are patterned in stripes, bars, dots or circles. Resembling the fish one might see in a coral reef, many are popular in home aquariums (Kingdon 1989). Various kinds of tilapia, which are also cichlids, form a major part of the diet of Africans living around these lakes, and they are being raised in aquaculture projects around the world.

These beautiful fish and their ancient ecosystems are now disappearing. The major cause is the Nile perch (*Lates niloticus*), Africa's largest freshwater fish, at more than 6 feet in length. Since 1960, the Uganda Game and Fisheries Department has introduced thousands of these fish as a food source for the local people, despite objections from the East African Fisheries Research Organization (Simon 1995). Even as a food fish, the Nile perch is not rated highly by the local Africans, who prefer the smaller tilapia, which they preserve by drying in the sun (Simon 1995). The flesh of the Nile perch is so oily that it must be smoked, and more and more trees must be cut down for this purpose (Simon 1995). An ecological disaster occurred after its introduction; although intended to increase the lake's productivity of fish, the opposite happened. Gradually, this predatory fish became the dominant species in the lake, and completely

destroyed the endemic cichlid fish fauna and fishery (Simon 1995). Of the more than 300 varieties of *Haplochromis* genus cichlid fish (including subspecies) endemic to Lake Victoria, almost two-thirds died out, and the rest became endangered (Simon 1995). Fifty known extinctions have beset Lake Victoria's endemic cichlids. One species, *Haplochromis pyrrhocephalus*, has become extinct in the lake Œ it exists only as a captive colony in the Horniman Museum in London (Simon 1995). Extinctions of the surviving cichlids continue because of predation by the Nile perch and siltation of the lake from erosion of farmland soil on its shores. This prevents these fish from mating because they are not able to recognize the brilliant colors and patterns of their potential mates (Yoon 1997).

The introduction of exotic fish threatens many freshwater species, and overfishing is virtually eliminating a large number of saltwater species. Research on the latter is lacking, but it is likely that many of the 156 species listed as ficriticalfl in the *2000 IUCN Red List* will be listed as extinct in the near future.

Amphibian Extinctions

Six species of amphibians Œ all frogs Œ are known to have become extinct since 1500. No recorded amphibian extinctions have taken place on islands, despite the large number of endemic amphibians native to large islands such as Madagascar, New Zealand, Cuba and Puerto Rico. Many of these, however, now face this threat. Yet it is likely that amphibian extinctions occurred as a result of the draining of wetlands or due to their use in growing rice following the colonization of the latter islands by native peoples thousands of years ago. The extinct frogs were mainland species, and all disappeared during the 20th century. The Israel painted frog (*Discoglossus nigriventer*) became extinct around 1940, when Lake Huleh, its sole habitat, was drained for agriculture. The Vegas Valley leopard frog (*Rana fisheri*) disappeared in 1960 when its desert spring habitat was destroyed by groundwater pumping for agriculture. Two Mexican frogs endemic to wetlands north of Mexico City died out by 1979 after their wetlands were drained for the construction of homes. The best known extinction in recent times is that of the beautiful golden toad (*Bufo periglenes*), which is acknowledged by most experts to have disappeared from its rainforest home on a Costa Rican mountain in the late 1980s. This species had been featured in National Geographic Society films and articles, and was also the subject of a research study when it suddenly died out.

A large number of frogs Œ at least 20 species Œ have not been seen for many years, and many may soon be declared extinct. Some of these are among the most unusual examples of evolution on Earth. In a few pristine areas, frogs have mysteriously vanished. An Ecuadorian biologist reported in the 1990s that a dozen species he had been studying in a high altitude meadow disappeared without a trace. Experts are in disagreement over the causes of the vanishing of so many frog species. Many species are believed to be victims of ozone depletion, which increases the amount of ultraviolet radiation reaching the Earth, destroying frog eggs and often adult frogs as well. Other scientists believe frogs are disappearing from a combination of causes, including disease possibly induced by an immune system lowered by pollutants, pesticides and habitat destruction.

Reptile Extinctions

All but one reptile extinction have occurred on islands. At least 28 island reptiles have died out since 1600. A large number of reptile extinctions took place in the Mascarene Islands, a group of islands in the Indian Ocean, east of Madagascar (see Appendix for more on Mascarene Island extinctions). Thousands of large tortoises were slaughtered for food by European settlers and visiting ships' crews during the 17th century. All three Mascarene Islands and most of their satellite islets were densely populated by various species of tortoises. Each island had species with differently

shaped shells: domed for feeding on low vegetation, and high•fronted for other vegetation (Day 1981).

Francois Leguat described Rodrigues' tortoises in the early 18th century: "There are such plenty of Land•Turtles on this Isle that sometimes you see 2,000 to 3,000 of them in a Flock; so that you can go above a hundred paces on their backs without setting foot on the ground. They meet together in the evening in shady places and lie so close that one would think those spots were paved with them" (Day 1981). The large tortoises must have numbered in the hundreds of thousands, judging from the quantity taken by ships to provision their crews and to trade for commodities. Each weighed about 100 pounds, and naval ships vied with one another for rights to them. The tortoises were plundered indiscriminately. Far more were killed than needed by crews and passengers (Durrell 1977). One expert estimated that at least 10 thousand tortoises were taken per year from Rodrigues island alone. Many died en route, as in the case of one shipment of December 6, 1761, in which the ship fiL'Oiseaufl arrived with a cargo of only 3,800 tortoises still living out of the 5,000 shipped (Durrell 1977). The Mauritian tortoises were extinct by 1700, the two Reunion species by 1773, and the Rodrigues species in 1800 (Day 1981). The last of the tortoises were killed off by pigs consuming the young tortoises and rooting up their eggs in the sand (Day 1981). Eight tortoise species, including three giant tortoises, became extinct (see Table "Extinct Wildlife of the Mascarene Islands").

In all, 13 Mascarene reptile species disappeared forever. The blind cave snake and three skinks or geckoes also disappeared. The most recent extinction was the Round Island Boa, which inhabited an islet off the coast of Mauritius. Livestock and rabbits stripped the vegetation, which caused the extinction of this snake by 1975. No native tortoises or turtles still exist on the Mascarenes. The remaining species of boa and the four gecko and skink species are highly threatened, according to the *2000 IUCN Red List.*

Elsewhere in the world, reptiles have been eliminated mainly as a result of the combined effects of non-native species, such as rats, cats and mongooses. Predators prey and compete for habitat and vegetation, livestock overgraze and settlers destroy habitats. Nine species of iguanas and snakes of the Caribbean became extinct after introduced species of mongoose and rats demolished them. The iguanas were also hunted heavily for food by local people. A number of iguana species barely survive on various Caribbean islands, having become restricted to tiny islets off the main islands where rats, cats and livestock are not present. Four Caribbean reptiles have disappeared. A lizard (*Ameiva major*) and a snake (*Dromicus cursor*) were native to Martinique and became extinct in 1960 and 1962 respectively; the other two were native to Jamaica. A tree snake (*Alsophis ater*) was probably eliminated by forest destruction and predation by the introduced mongoose. The Jamaican iguana (*Cyclura collei*), thought to be extinct, was recently rediscovered, but the species is still highly endangered. The single reptile extinction on a mainland area was a South African lizard, Eastwood's longtailed seps (*Tetradactylus eastwoodae*) Œ it disappeared in 1913.

Bird Extinctions

A bleak picture has emerged, showing a dramatic rise in the rate of bird extinctions over the past 200 years. At least 157 species of birds have become extinct since 1500, and many more have not been seen in decades. In pre-history, approximately one bird disappeared each century (Leakey and Lewin 1995), but the present rate is many times that. During the 17th century, 15 birds disappeared, increasing to 26 birds in the 18th century (at an average rate of about one bird every four years); this was 26 times the pre-history rate. Nineteenth century extinctions totaled 56 bird species, or about a bird every other year. Data for the 20th century is still being totaled, but 54 birds have already been declared extinct since 1900 Œ already almost as many as the entire 19th century™s toll. Thus, the rate of avian extinctions has likely more tripled since the 18th century. A large number of birds have not been seen in the wild for many decades and will likely soon be declared extinct; a period up to 50 years between the last sighting and formal declaration of a species' extinction is generally accorded, unless thorough surveys verify the species is indeed gone.

An important dimension of these extinctions is the fact that birds are considered indicators of the planet's health. Birds are sensitive to environmental pollution, habitat loss and other signs of deterioration, as illustrated when canaries were used by coal miners to test for the presence of lethal methane gas. Their extinctions will also affect the ecosystems in which they once lived, since many birds pollinate plants or disperse seeds, and without them, these plants die off. The story of the dodo (*Raphus cucullatus*) is an example of such a relationship.

Some of the most amazing and unusual species that ever lived are among the birds that have become extinct since 1600. Many of these extraordinary birds evolved on remote islands without human inhabitants over periods of millions of years. The heaviest bird ever to have lived on Earth was the Great elephant bird (*Aepyornis maximus*) of Madagascar, the last of many related species of elephant birds. Some experts maintain this giant bird disappeared prior to 1500 (Brooks 2000), but observers spoke of its continued presence on the island after 1600. The giant moas of New Zealand are thought by some to have persisted until the 19th century, while others believe they died out a thousand years ago, within a few centuries after the arrival of the Maori people. The brawny great moa (*Didornis torosus*) of New Zealand was perhaps the last of many species of moas, the largest of which was the tallest known bird, some 12 feet in height. It was hunted to extinction like its relatives. Some said it persisted until 1670. Another extraordinary New Zealand bird was unique in that males and females had beaks that were completely different in both size and shape: the colorful huia (*Heteralocha acutirostris*) became extinct early in the 20th century, mainly from the effects of forest destruction and hunting for its feathers, which were sold in the European markets for ladies' hats.

The Mascarene Islands, which remained uninhabited by humans until the 17th century, once had an unparalleled diversity of birds, including an array of many odd flightless birds such as the famous dodo. Flightless herons and storks fished in the streams, and enormous parrots Œ their beaks as large as their heads Œ lumbered about in search of fruits and seeds. Each island had its own distinctive parrot species. Some of the native parrots had not become flightless, and each of the seven or so species occupied its own ecological niche. Gray parrots with bright red beaks, small gray parakeets and two types of lime green parrots with very long tails swooped about in large flocks (Fuller 1987).

Large numbers of the flightless, turkey•sized dodos waddled about on Mauritius. The birds, weighing about 50 pounds and covered with grayish, downy feathers, fed on hard-shelled seeds. Of all birds that have become extinct, this species is perhaps the most famous. The dodo™s common name apparently came from fidodoor,fl a Dutch word meaning sluggard, and dodaers, a lubber, or awkward sailor (Halliday 1978). The creature's original scientific name was *Didus ineptus*, indicating its inability to flee humans or defend itself.

In fact, the dodo was the final result of thousands Š perhaps millions Š of years of evolution in isolation on an island with no land predators. Wild pigeons of an unknown species landed by chance on Mauritius at some early date and became resident, gradually evolving into a gigantic form of the original immigrant. The dodo may have evolved from New Guinea and Pacific Islands tooth•billed pigeons that landed in the Mascarenes, according to some zoologists (Halliday 1978). Tooth-billed pigeons also have curious hooked beaks, although the dodo's 9 inch beak was far more massive. Yet whatever its ancestry, the dodo became flightless in its predator•free environment. Its feathers lost their sheen and aerodynamic quality and came to resemble the down of nestling birds.

Mauritius was first visited in the early 16th century by Portuguese sailors, and was later settled by the Dutch, who brought pigs, goats and cattle. These domestic animals soon multiplied and overran the islands. Pigs rooted in forests, devouring rare flora, and cattle and goats overran the fragile tropical vegetation. Rats swam from ships and colonized the main islands; they preyed on flightless birds, eating their eggs and young, even climbing trees to devour nesting songbirds. Mongooses native to Asia were brought to Mauritius, which presented a lethal threat to native birds and other wildlife. Long-tailed macaques (*Macaca fascicularis*) were imported as pets at some point from Southeast Asia and then released into the forests of Mauritius, spreading throughout the island and preying on native birds. Settlers also cut the trees needed by native birds for habitat and food. The delicate plants, forests and vulnerable wildlife were devastated by this onslaught.

Portuguese and then Dutch seamen and colonists slaughtered thousands of dodos, using them as a major source of food. They cut down the seed-bearing trees dodos fed upon, and their eggs and chicks may have been preyed on by rats and introduced macaques (Fuller 1987). Settlement began in 1634, and within less than 30 years, the once-common dodos were slaughtered to extinction. The settlements failed and Mauritius remained uninhabited for a period of time.

The last account of wild dodos dates from 1662. A Dutchman named Volquard Iversen was deserted on Mauritius soon after both the early settlement and the penal colony failed (Quammen 1996). Iversen and his shipmates scoured the island for food and found no dodos, but they did see some on a small islet off the coast. He described them as "larger than geese but not able to fly. Instead of wings they had small flaps; but they could run very fast" (Quammen 1996). The islet protected the last few dodos from human hunters and introduced predators, and until then, the tiny population had remained undetected. Iversen's party waded through the shallow water to the islet and captured a dodo. "When we held one by the leg he let out a cry, others came running forward to help the prisoner, and they were themselves caught" (Quammen 1996). These were the last of their species. Altruism, a trait that has helped many animals survive through mutual aid, has also caused extinctions. Human hunters have taken advantage of this, killing animals that come to the aid of each other.

In the centuries since its demise, the dodo has come to symbolize extinction, but many still think of this bird as stupid, giving rise to the expression "dumb as a dodo." Animals are frequently deemed stupid if their natural defenses against humans are inadequate, or vicious if they are able to defend themselves. Yet this bird so many people have described with disdain came to the rescue of its fellows, even at the risk of its own life, and was an extremely successful species within its environment. If the word dodo must be seen symbolically, then it would be more reasonable to equate it with human stupidity, because our own species wantonly destroyed this extraordinary bird. In the opinion of Errol Fuller (1987), author of the authoritative book *Extinct Birds*, "The dodo was one of the most fantastic creatures ever to have lived."

In 1973, Dr. Stanley Temple, an ornithologist, made a remarkable discovery about the dodo. He noticed that a beautiful tree native to the island, the calvaria or tambalacoque tree, was reduced to 13 dying specimens, all more than 300 years old. Gerald Durrell (1977) described these trees as at least 50 feet tall, with massive crowns and silvery, gnarled trunks; cracks appeared in their buttress roots. Since no young trees were located, it occurred to Dr. Temple that no seeds had germinated since the 17th century when the dodo became extinct. Apparently, stones found in the dodo™s gizzard by sailors butchering it for food might have been able to abrade the thick shell covering the seeds. Dr. Temple fed some of the seeds to domestic turkeys, which were presumed to have similar digestive systems, and of 10 seeds recovered from feces or regurgitation, three sprouted when planted (Anon. 1978).

Some scientists now believe this tree could germinate without the dodo. A surviving parakeet is thought to be able to crack its hard-pitted seeds, and the extinct Mauritius flying fox and some of the extinct parrots were able to do so as well(Quammen 1996). Dr. Wendy Strahm, in her botanical work on Mauritius, has found young trees of this species that germinated in the past 300 years, although they are quite rare (Quammen 1996). Another scientist, Anthony S. Cheke, believes seed germination has continued, but at a low rate Œ perhaps too low to maintain the species long-term. The rarity of the tambalacoque tree was considered to be due to seed predation by rats, deer browsing on saplings, rooting by pigs and perhaps browsing by the introduced macaque monkeys (Quammen 1996). Yet dodos were likely major seed distributors of this tree in the pre-human environment, and their role has not been successfully replaced ecologically. The introduction of a veritable zoo of non-indigenous species has reaped havoc on a variety of native plants.

The dodo's close relatives on neighboring islands are far less known. On Reunion, a bird called the Reunion solitaire (*Raphus solitarius*) was described by early visitors to the island as resembling the Mauritius dodo, except its beak was somewhat smaller, its plumage was white and the tips of the wings and the tail were black (Fuller 1987). One traveler, M. Carre, said in 1699: "The beauty of its plumage is a delight to see. It is of changeable color which

verges upon yellow" (Fuller 1987). Two were taken aboard ship as a present to the French king, but both refused to drink or eat and soon died. M. Carre noted in his description that "The flesh is exquisite; it forms one of the best dishes in this country, and might form a dainty at our tables" (Fuller 1987). This was an ominous prediction of its final fate. The Reunion solitaire probably died out about 1715 as a result of being slaughtered for food.

On tiny Rodrigues, yet another dodo-like bird existed. Far more is known of this species, whose bones have been found in caves on the island. Its beak was shorter and its neck was longer, but it also apparently evolved from pigeon ancestors (Halliday 1978). It was called the Rodrigues solitaire or solitary (*Pezophaps solitaria*) for its habit of feeding alone on leaves and fruit in secluded places. Errol Fuller's description in *Extinct Birds* evokes its once peaceful existence: "In this tranquil kingdom generations of solitarys must have lived enjoying extraordinary peace and seclusion until their world was shattered by the coming of man."

Francois Leguat, a Huguenot refugee, left extensive descriptions of these birds when he spent two years on Rodrigues after he was marooned there with a small group of followers in 1691 (Fuller 1987). "They walk with such stately form and good grace," Leguat wrote, "that one cannot help admiring and loving them" (Fuller 1987). He watched them nesting and feeding their chicks until they fledged at several months. The male and female defended their territory, driving other solitaires away with a dramatic display in which a bird pirouetted for four to five minutes while whirring its wings violently to produce a loud rattling noise that could be heard 200 yards away (Halliday 1978). If this impressive display did not frighten other birds away, they used knobby growths at the joints of their flightless wings in combat with other solitaires (Halliday 1978). Some wing bones now found in museums have healed fractures, an indication of the violence of these encounters (Halliday 1978).

Leguat saw the parents of solitaires escorting their single chick to a gathering of some 30 other solitaire families, where the adults would leave the chicks. Tim Halliday wrote in *Vanishing Birds* (1978) that he believes what Leguat witnessed was actually a sort of nursery gathering, similar to that which flamingos and some penguins organize while adults go off to feed. Although these birds were able to hide in foliage and could run quickly, hunters chased them down and butchered every last bird. People slaughtering them found stones in their gizzards Œ even in those of very young nestlings. How they got there remains a mystery, since the stones were too large to have passed down the gullet (Halliday 1978). The last solitaire was seen around 1746, and the species was deemed extinct by the 1760s (Brooks 2000).

The origin and affinities of these three species of pigeon-like birds in the Mascarene Islands will be disputed by scientists for some time to come. Tim Halliday (1978) conjectured that the dodo may have evolved from a pigeon, such as the tooth-billed pigeon (*Didunculus strigirostris*) of the Pacific Œwhich has a similar but far smaller hooked bill Œ or that they were related to rails. It is also possible the dodo had one ancestor and the solitaires had another. What is not disputed is that they left no close relatives. No living birds on Earth are related to the dodo and the solitaire, or bear any strong resemblance to them.

Other flightless native birds of the Mascarenes disappeared as well: all the huge parrots, three kinds of owls, three rails, several small pigeons, two night herons, a stork and an ibis. Little is known about many of these birds, but two of the rails were described in detail. The Rodrigues or Leguat's rail (*Aphanapteryx leguati*) had bright gray plumage flecked with white and gray, a curved red bill, red legs and feet and a red ring surrounding the eye (Taylor 1998). The bird™s call consisted of a long whistle, but when pursued, the rail gave an alarm call that sounded like a person with a hiccup (Taylor 1998). This species fed on tortoise eggs and, like the related Mauritian red rail (*Aphanapteryx bonasia*), could be lured by holding out a red object and trapped when the bird came to attack the lure (Taylor 1998). They were described as delicious, and were killed to the last bird. Among flighted species lost were a type of weaver, a starling and a falcon (Brooks 2000; Fuller 1987; Greenway 1967). The total of 31 extinct birds is more than that of any other island group or continent.

However extraordinary such a toll may seem for a group of small islands, it may represent only a percentage of Mascarene avian extinctions. Stanley Temple estimated that prior to the arrival of humans, 68 species of birds lived

on the three main islands and, of these, 45 species (66 percent) became extinct after 1600 (Temple 1981). The 14 species not officially included among the extinct birds of these islands were described by travelers but have not yet been authenticated. The majority lived on Mauritius. Future archeologists are certain to discover far more about the birdlife that once inhabited these islands, and genetic studies of specimens from which DNA can be extracted may help identify their origins.

The Hawaiian Islands vie with the Mascarenes for numbers of extinctions. At least 21 species and many more subspecies have become extinct since 1600. One of these was native to the remote swamps of Kauai. The Kauai Oo (*Moho braccatus*) had pitch black plumage brightened by several long, canary yellow feathers. The male had a haunting, fluted call. The species dwindled as forests were cut, and by 1960, only 12 birds were known to remain. A single pair survived by the 1980s. The female disappeared after a hurricane in 1985 (Brooks 2000), and the male lived on a few more years as the last member of his species. He was seen singing and building a nest with each final year, trying to attract a mate who never came (Daws 1993). He was last seen in 1987 (Brooks 2000).

The Kauai Oo was the last of a group of dramatic songbirds that once lived on all the major islands. The Hawaiian honeycreepers found only here evolved from one or a small number of ancestor species Œ likely a New World finch, warbler or honeyeater Œ into an estimated 40 to 50 brilliantly colored birds, before the arrival of the Hawaiian people. Some species were probably eliminated after they were killed in tremendous numbers for their feathers, then made into elaborate headdresses and cloaks for Hawaiian royalty, but the major cause of their extinction was the destruction of their forests by European settlers. As the honeycreepers retreated to smaller and smaller habitats, often surrounded by ranchland, sugar cane and pineapple farms, their habitats and food trees disappeared. Their fragmented populations were susceptible to avian malaria, which spread throughout the islands in the 20th century, brought by exotic cage birds that had escaped or been released by their owners. Thousands of birds died of the disease. The extinction toll of native birds within the past few hundred years stands at 21 species, in addition to even more subspecies. Twenty-three honeycreepers survive, but most are so endangered they are not expected to survive more than a few more decades. One critically endangered honeycreeper, the po'o-uli (*Melamprosops phaeosoma*), has a total population of three birds: two males and one female live in a reserve and the adjacent Haleakala National Park on Maui (BI 2000). This small, masked brown-and-white bird, discovered in 1973 by a graduate student, once numbered 200 individuals before it underwent a drastic decline between 1975 and 1985 as a result of avian malaria and habitat destruction by feral pigs within its reserve (BI 2000). All three birds live in separate home ranges, and the species has little chance of survival.

Rails are the most characteristic of all island land birds. These compact and stocky creatures are most frequently seen in wetland habitats, but some live in forests or grasslands. Almost all islands in tropical latitudes have or had endemic rails or fossil evidence of their past presence. Larger islands have several native rails, and it has been estimated that as many as 2,000 flightless rails inhabited Polynesian and western Pacific islands alone, prior to their colonization or visits by humans who exterminated them. Many of these instances were in prehistoric times by Maori, Hawaiians and other native peoples (Taylor 1998). Some 23 species of island rails, virtually all flightless, have been exterminated since 1500 Š far more than any other avian family (see Appendix).

Rails are not likely candidates for colonizing islands because they are, in the words of S. Dillon Ripley (1977), an authority on rails, "loath to fly." When frightened, they usually do not take wing, but disappear into matted vegetation. When they do fly for short distances, it is rather feebly, and their legs dangle down. How could they have reached islands thousands of miles from the mainland? Some rails are long-distance migrants, while other species disperse in erratic patterns (Taylor 1998). Rails tend to travel in groups at night and are often blown off course. European rails on their way to Africa have ended up far from their wintering site (Taylor 1998). European Corncrakes, for example, have landed, exhausted, on ships in the Indian Ocean or even off New Zealand (Ripley 1977). North American Purple Gallinules, colorful rails of southern marshes, have flown to tiny Tristan da Cunha island halfway between South America and Africa in the South Atlantic (Ripley 1977). The Common Moorhen (*Gallinula chloropus*) of Eurasia, North and South America and Africa has colonized St. Helena, the Azores, the Seychelles, the Marianas and Hawaii, among other islands. These colonizing rails usually become flightless if they

have are no enemies, such as native predators. Some become the size of large chickens. Once flightless, however, they are vulnerable to predation by animals brought by humans.

The Laysan rail or crake (*Porzana palmeri*) was driven to extinction by imported rabbits who rendered Laysan Island devegetated. Biologists transported it to nearby Midway Island, where it flourished until World War II, when the island became a naval base. The navy personnel were entranced by this utterly fearless and agile bird that sprung into people's laps or onto the mess table in search of crumbs of food. Unfortunately, the species perished soon after 1942, when rats from a naval landing craft apparently ate the rail's eggs and preyed on its young. A few of the rails had been returned to Laysan Island after rabbits were removed, but the vegetation had not recovered sufficiently and the birds did not survive (Ripley 1977). Most other island rails have died out from similar causes.

Since about one-third of the world's birds are endemic to islands, and they have been reduced by 30 to 50 percent since humans came to these islands. Their extinctions represent a true biological catastrophe, in the words of Storrs Olson, an authority on extinct birds (Taylor 1998). The vast majority of avian extinctions in the past 500 years have been island birds Œ victims of predation, competition from introduced animals and disease from cagebirds. Many were also killed for food or trade. Non-indigenous species are still causing bird extinctions on islands. In all, 137 of the 157 bird extinctions (87 percent) since 1500 have been island species, and human activities and animals introduced by humans have been responsible. Island species have been more vulnerable to extinction than mainland species because of their small populations and limited habitats. Many were flightless or slow-moving species, unable to flee predators, including humans. Some were specialized in their diet and habitat and could not adapt to changes made in their environment.

Mammal Extinctions

Cuba, Puerto Rico, Hispaniola and Jamaica had a variety of unusual native rodents and shrew-like insectivores prior to the arrival of European explorers and settlers in the 1600s; many were ancient species. When native Caribbean populations settled the islands after the Ice Ages, rodents as big as marmots inhabited the larger islands. A type of giant sloth lived in Puerto Rico, and a rodent nearly the size of the American black bear inhabited the small islands of Anguilla and St. Martin until it was apparently hunted to extinction by natives (Olson 1978). Cuba, Puerto Rico and Hispaniola were once attached to the mainland of Central America, but this large land mass became separated and drifted off into the Caribbean. Some of the native fauna and flora present more than a million years ago survived until a few thousand years ago, and tiny frogs and butterflies from that period persist today.

When Europeans colonized the Caribbean islands, they began cutting forests and replacing them with huge plantations of sugar cane, other crops and grazing land for livestock. They imported thousands of slaves to farm the land. Mongooses were brought on the islands to control snakes, but they preyed on native mammals and birds instead; rats arrived in ship holds and did the same. Fifteen mammals have become extinct on Hispaniola, the island divided between present day Haiti and the Dominican Republic Œ this island suffered the highest number of mammal extinctions of any Caribbean island. Forests have been nearly obliterated on Haiti, which is another cause of extinctions. Cuba, Puerto Rico and Jamaica have likewise lost the majority of their forest cover, as well as many native mammals, including bats, rodents and insectivores. Jamaica was home to a monkey (*Xenothrix mcgregori*), making it the only Caribbean island with a native primate. It was hunted and its forest habitat was cut by European colonists, and it died out in the 1750s. Various species of hutias, large rodents found on most major islands, became extinct as well. Hutias remain on a few Caribbean islands but are close to extinction from forest destruction and predation by introduced mammals.

Most of the 40 mammals that became extinct on Caribbean islands after 1600 were rodents and insectivores. A muskrat and a rice rat became extinct on Martinique when Mt. Pelee erupted in 1902 Œ one of the few examples of a naturally caused modern extinction. Hutias, large rodents that resemble South American agoutis, proliferated into a variety of species on the large islands of the Greater Antilles. Settlement, deforestation and hunting caused at least five species of hutias to become extinct, and the few remaining species are now highly endangered.

The first mammal to disappear after 1600 was a massive wild cow called an auroch (*Bos primagenius*). This species, native to most of Europe, lived in the deciduous forests that once covered most of the continent. The auroch was also hunted for its meat and died out about 1627. Several other wild cattle related to the auroch survive in Southeast Asia, but they are critically endangered. The tarpan (*Equus gmelini*), a wild horse of Europe, gradually became rare and restricted from hunting and destruction of its native forests during the Middle Ages. The last wild tarpans were killed off in 1851 (Day 1981). Both the auroch and the tarpan are depicted by Pleistocene humans in magnificent cave paintings found in southern Spain and France.

The Steller's sea cow (*Hydrodamalis stelleri*) was an enormous 24 to 30 feet long marine mammal, similar in appearance to the dugong and the manatee. The sea cow was larger, however, and swam in the cold arctic waters of the Bering Sea, enduring temperatures that would kill its closest relatives. The slow and sluggish sea cows were killed off only 27 years after their discovery. They were first seen by the shipwrecked crew of the explorer Vitus Bering in 1741 in the vicinity of Bering Island in the Commander Islands, off the eastern coast of Russia's Kamchatka Peninsula. These sea cows were tame and easy to spear and harpoon by the ship crews who killed most of the population, calculated at only about 1,500. This animal showed extreme protectiveness toward its fellows and strong bonds between mates. The naturalist Georg Wilhelm Steller, after whom the species was named, described their behavior on being harpooned.

. . . Some of them tried to upset the boat [when another sea cow was struck] with their backs, while others pressed down the rope and endeavored to break it, or strove to remove the hook from the wound in the back by blows of their tail, in which they actually succeeded several times. It is most remarkable proof of their conjugal affection that the male, after having tried with all his might, although in vain, to free the female caught by the hook, and in spite of the beating we gave him, nevertheless followed her to the shore, and that several times, even after she was dead, he shot unexpectedly up to her like a speeding arrow. Early next morning, when we came to cut up the meat and bring it to the dugout we found the male by the female, and the same I observed on the third day when I went there by myself for the sole purpose of examining the intestine (Day 1981).

Australia has been the scene of more mammal extinctions than any other continent or island group. Beginning in the 19th century, Australia's mammals disappeared in large numbers. Native marsupials and rodents were gradually eliminated by massive habitat destruction and predation from animals introduced by European settlers. Twenty-two mammals became extinct after 1600. A wide variety of marsupials, from small species to wallabies, was extinguished within a century of settlement. Some, like the thylacine, or Tasmanian wolf (*Thylacinus cyanocephalus*), were deliberately persecuted by livestock ranchers under the misapprehension that the species presented a threat to flocks.

The crescent nailtail wallaby (*Onychogalea lunata*) was native to the gum forests of western Australia where John Gilbert, a 19th century museum collector, found the animal common in thick scrub, "where it is occasionally seen

sunning itself" (Strahan 1995). This small marsupial weighed less than 20 pounds and looked like a miniature kangaroo. It rested in hollows in soft ground beneath shrubs during the day, feeding mainly at night on roots and coarse grass (Nowak 1999). When chased, it would run to a hollow tree with a hole in the bottom and clamber up the sides until it got high up within the trunk; aborigines used smoke to chase them out and then killed them for food (Strahan 1995). The aborigines also hunted these animals by building brush fences and enclosures and driving the animals into areas where people waited with clubs (Strahan 1995). In spite of hunting, this wallaby was fairly common until 1900, and many were collected for museums (Strahan 1995). It disappeared from the southern portion of its range early in the century after intensive forest clearance and development of the country for agriculture. Gradually, it became very rare, and disappeared altogether from the wild in the 1960s (Nowak 1999, Strahan 1995). Some experts suggested the removal of the thickets where these wallabies sheltered during the heat of the day left them homeless and vulnerable to predation (Nowak 1999).

Millions of acres of eucalyptus forests and mulga woodlands of southern and western Australia were clearcut by settlers beginning in the 19th century, opening up the land to wildfires (Lines 1991). The devastation of these habitats was described in *Taming the Great South Land. A History of the Conquest of Nature in Australia*, by W.J. Lines (1991). The combination of this habitat destruction, hunting and introduced predators, such as feral dogs, was responsible for the extinction of the Crescent Nailtail wallaby and many other native marsupials.

Various endemic Australian rodents and bats died out as well, and many of the remaining native mammals are become confined to tiny islands off the coasts Œ the only habitats where introduced animals are absent. Australia is like an island in having been isolated from other land masses for millions of years, and the majority of its mammals are endemic to the continent. In fact, it is often referred to as the "Island Continent." If Australian extinctions are included among those on islands, 87 percent of all extinctions of vertebrates other than fish have occurred on islands.

In Asia, the freshwater baiji dolphin species was until recently found throughout the Yangtze River and its surrounding lakes and tributaries. Unfortunately, the exponential growth of the Chinese population posed a variety of threats to its survival. A lack of information, growing threats and the species' small population size eventually led to the baiji's decline, despite protective efforts. Baiji dolphins were last officially sighted in 2004, and a 2006 expedition deemed the species "functionally extinct."

THE GEOGRAPHY OF EXTINCTION (chart)

1600 to present					
	Number of Species Extinct				
Islands	**Birds**	**Mammals**	**Reptiles**	**Amphibians**	**Total**
Atlantic Islands					
Ascension I.	1				1
Canary Is.	1		1		2

Cape Verde Is.			1		1
Falkland Islands		1			1
Gull Island (Off NY, USA)		1			1
Iceland, Funt I. (Canada)	1				1
St. Helena	7				7
Subtotals	10	2	2		14
Caribbean					
Barbuda		2			2
Barbados		1			1
Bahamas	1				1
Caribbean region	2	1			3
Cayman Is.	1	1			2
Cuba	1	7			8
Guadeloupe	2		1		3
Hispaniola (Haiti & Domnican Republic)	1	15			16
Jamaica	4	2	2		8
Martinique	1	2	3		6
Navassa I.			1		1
Puerto Rico		6			6
St Croix (Virgin Is.)			1		1
St Lucia		2	1		3
St Vincent		1			1
Subtotals	13	40	9		62
Indian Ocean Islands					
Amsterdam Island	1				1
Christmas Island		3			3
Madagascar	2	1			3
Mascarene Is.	31	1	13		45
Seychelles	2		1		3
Subtotals	36	5	14		55
Mediterranean					
Sardinia		1			1
Subtotal		1			1
Pacific Islands					
Auckland I.	1				1
Bering I. region	1	1			2

Bonin Is.	3	1			4
Caroline Is.	3				3
Chatham Is.	5				5
Fiji Is.			1		1
Galapagos Is.		7			7
Guadalupe I.	2				2
Guam	1	1			2
Hawaiian Is.	21				21
Lord Howe & Norfolk Is.	6				6
Kangaroo I. (Australia)	1				1
Marquesas	1				1
New Caledonia	4				4
New Zealand	14	1	1		16
Okinawa		1			1
Pacific region	1				1
Palau		1			1
Philippines		3			3
Ryukyu Is.	1				1
Samoan Is.	1				1
Santa Cruz Is.		1			1
Society Is.	7				7
Solomon Is.	1				1
Tonga Is.	1				1
Vanuatu	1				1
Wake I.	1				1
Subtotal	77	17	2		96
Asia					
Indonesia	1				1
Subtotal	1				1
Island Totals	137	65	27		229
Mainlands					
Africa		5	1		6
Asia	2	1			3
Australia	2	22			24
Europe & Near East		2		1	3
Mexico & Central America	3	4		4	11

North America	3	1		1	5
South America	10				10
Mainland Totals	20	35	1	6	62

Source: Table of Extinct Species in the Appendix of this book. Sources of information are listed with the table.

Note: See the Appendix for the list of these species in chronological order, and the references that describe these animals and their extinctions, as well as those that include illustrations of the extinct species.

The following account chronicles some of the many extinctions and destructions of natural ecosystems that have taken place in North America over the past few hundred years. Great biological treasures have been stolen from future generations, and the processes by which they were lost are typical of those occurring elsewhere in the world. The sudden loss of the most abundant and prominent wildlife species of the continent created a profound shock in the public early in the century that set the stage for today's conservation and humane programs. This concern may turn the tide for species that could suffer the fate of the passenger pigeon (*Ectopistes migratorius*) and others, but unless public opinion is better translated into public policy regarding the land and wildlife, further losses will occur and the lessons that might have been learned will be ignored. A strong and pragmatic commitment to preserve what remains of the natural world on the continent, based on a realization that our fate is linked to nature's fate, is essential to prevent further extinctions.

Epitaphs for North America's Lost Species and Environments

After the loss of the majority of large Pleistocene mammals, native peoples in North America became conservationists of the remaining wildlife and the continent's environment. Many tribal religions deified animals and believed they embodied the spirits of their people. They hunted and fished on a subsistence basis. This resulted in relatively few animal extinctions over the tens of thousands of years that passed before settlement by Europeans in the 16th century. The land that awaited new settlers was spectacular in its beauty and abundance of wildlife. Over the next three centuries, however, an unprecedented level of slaughter and drastic environmental alteration destroyed many of these natural treasures.

An Abundance of Wildlife

Early European voyagers landing on the East Coast of North America were astounded to see animals in numbers they had never before witnessed. Fish swarmed in the millions. Captain John Smith came upon vast schools of fish in tributaries of the Potomac River, near the Chesapeake Bay, in 1608: "–in diverse places that abundance of fish lying so thick with their heads above the water [that] as for want of nets (our barge driving among them) we attempted to catch them with a frying pan, but we found it a bad instrument to catch fish with. Neither better fish, more plenty, nor more variety for small fish had any of us ever seen in any place so swimming in the water–" (Hawke 1970). Lobsters were so prolific that one haul of a fisherman's net would bring in more than 100; settlers used them as fertilizer and fish bait. Huge sturgeon 10 feet long swam up major rivers to spawn along the East Coast. Offshore, whales and herds of dolphins migrated along the coasts. The northern right whale (*Eubalaena glacialis*) fed on plankton in shallow lagoons as it migrated to its breeding grounds off Florida. The now-extinct Atlantic gray whale (*Eschrichtius robustus*) was a common marine resident, swimming and feeding offshore. At the present sites of Boston, New York

and Philadelphia, vast saltwater marshes surrounded river deltas. Shorebirds and waterfowl darkened the sky with their millions.

Along the craggy rock•strewn coasts of Maine and the Canadian maritime provinces lived a large mink, almost double the size of the American species found elsewhere in the country. Unlike any other type of mink in the world, the animal was a coastal species that soon became known to colonists and fur trappers as the sea mink (*Mustela macrodon*). One sea mink killed in 1867 measured 32.5 inches in length, enormous in comparison to the American mink, which does not exceed 23 inches (Mowat 1981). The sea mink's pelt had twice the value of the inland species in the fur trade (Allen 1942).

An early account by the English naturalist Joseph Banks, who traveled to Newfoundland in 1766 to study the local fauna, described the sea mink as "bigger than a Fox, tho not much, in make and shape nearest compared to an Italian Greyhound, legs long, tail long and tapering" (Mowat 1981). It is unlikely that the sea mink was as long•legged as a greyhound, but available information indicates it was quite different from any closely related species. Bones from the sea mink have been found along the coast of Maine and New Brunswick (Allen 1942). The fur traders decimated these minks long before scientific or biological studies could be carried out. One early observer described the avid pursuit of sea minks in Maine:

> *Some seventy•five years ago, and for many years thereafter, my father, who was a fur•buyer, used to have nearly all the furs taken on the islands of Penobscot Bay . . . these sea mink used to bring considerably more than others on account of their great size . . . they were persistently hunted . . . with dogs trained for the purpose. As the price of mink rose, they were hunted more and grew scarcer, 'til in the sixties, when mink skins brought eight or ten dollars apiece, parties who made a business of hunting nearly or quite exterminated the race. Some of these men went from island to island, hunting any small ledge where a mink could live. They carried their dogs with them, and besides guns, shovels, pick•axes and crow•bars, took a good supply of pepper and brimstone. If they took refuge in holes or cracks of the ledges, they were usually dislodged by working with shovels and crow•bars, and the dogs caught them when they came out. If they were in the crevices of the rocks where they could not be got at and their eyes could be seen to shine, they were shot and pulled out by means of an iron rod with a screw at the end. If they could not be seen, they were usually driven out by firing in charges of pepper. If this failed, then they were smoked with brimstone, in which case they either came out or were suffocated in their holes. Thus in a short time they were nearly exterminated* (Beard 1947).

The last known sea mink was killed in 1880, and its pelt was sold to a fur buyer in Jonesport, Maine (Mowat 1981). Only fragments of bones and teeth found in excavations of Indian cooking sites attest to its existence (Nowak 1999).

A beautiful North American waterfowl species also disappeared. The male Labrador duck (*Camptorhynchus labradorius*) had striking black•and•white plumage, while the female was mousy brown. During the 19th century, these birds were often seen in fall and winter off New York's Long Island and on the New Jersey coast. Named for the Canadian peninsula where naturalists of the day assumed that they bred, eggs reported to belong to this species had been seen by a naturalist, but the nests were never found (Greenway 1967). This duck had a soft bill, and inside its mouth, lamellae filtered its food. The Labrador duck was assumed to have a specialized diet, possibly of small

surface invertebrates that it filtered while dabbling at the surface. The ducks also fed on mollusks, as hunters discovered when they caught them with fishing lines baited with mussels (Fuller 1987).

Labrador ducks were strong flyers who flew in tight, small flocks (Day 1981). Along with virtually all waterfowl of the day, they were shot for the feather and food markets. Gunners killed entire flocks of waterfowl, bringing them to market, where they were heaped in piles. The ducks were killed for no purpose, since they were not sought after as food and considered too "fishy" by most customers. Many of the birds shot by hunters were left to rot, unsold at markets (Day 1981, Greenway 1967). The Labrador duck, first described scientifically in 1789, was always considered rare, and the last known specimen was a bird shot off Long Island 86 years later, during the autumn of 1875. This male is kept in the US National Museum of Natural History (Fuller 1987). The Labrador duck was apparently hunted to extinction, a victim of the totally unrestricted waterfowl hunting that characterized the 19th century, based on its prevalence in game markets (Day 1981).

Further north, a flightless bird walked upright on its flippered feet. At a length of 3 feet, the great auk (*Alca impennis*) was the size of a large penguin, and could have been mistaken for one. Like many northern seabirds, it had a black back and white belly, but each side of its face was dramatically marked with a large, white oval. Its bill was long and hooked. Great auks were far larger than any of their cousins Œ the murres, puffins and guillemots of the North Atlantic. At one time, these birds ranged along most of the coasts and islands of the North Atlantic, from northern France through Scandinavia, England, Scotland and Iceland, to North America's eastern coast as far south as Martha's Vineyard, Massachusetts (Greenway 1967). Based on fossil evidence, great auks were once as numerous as most other sea birds of the region (Greenway 1967).

The very oldest bones, excavated on the island of Jersey in the English Channel, are between 70 and 90 thousand-years-old (Greenway 1967). As the only flightless bird in the North Atlantic, it was once widespread and numerous. When people approached the birds while they were on land nesting, great auks would immediately waddle to the water's edge and dive in. They were rapid and expert swimmers, using their wings to propel them. When cornered on land, however, they were helpless. Both parents raised the chicks, and they refused to desert their nests, even when attacked. For centuries, hunters took advantage of this trait, pursuing and killing them during their breeding season. Ship crews slaughtered thousands for provisions and took live birds on board for future meals.

Gradually over the centuries, great auks disappeared from most European coastlines and offshore islands as a result of hunting. The last record in the British Isles was on St. Kilda, an island west of northern Scotland, where some local residents captured a Great Auk in 1821; although kept captive with a string attached to its foot, it managed to escape (Fuller 1987). Twenty years later, as recounted by an older resident, another auk was found asleep on a rock on the same island and captured, kept for three days, and then killed because these superstitious people feared that it was a witch (Greenway 1967).

Great auk feathers were harvested in grisly "factories" on Funk Island off Newfoundland in the 18th century. Collectors built pens of piled boulders into which they would drive the hapless great auks from their nests. Once the auks were cornered in the pens, the men would swing spiked clubs at the birds, killing or wounding them (Day 1981). The birds were then thrown over the enclosure walls into piles near the fires; there the dead and wounded birds were dropped into boiling cauldrons or thrown directly on the fires (Day 1981). The boiling water caused the feathers to float to the surface, where they were scooped up and stuffed into bags; the corpses were next dragged down to the water where they were dumped (Day 1981). Some observers, including Captain George Cartwright, an early colonist on Labrador, watched boats coming ashore laden with hundreds of carcasses from Funk Island. He wrote in July 1785, "If a stop is not soon put to that practice, the whole breed will be diminished to almost nothing" (Birkhead 1994). By 1800, all the island's great auks had been killed. The ashes and pens still remain on Funk Island as the only reminder of this extraordinary bird.

Islands off Iceland and Newfoundland became the last refuges of the great auk. When word spread in the 19th century that the species was nearing extinction, hunters went in search of them for museums and egg collections. The

eggs and skins of the Garefowl, as it was known to Europeans, were sold at auction in London and to European museums for very high prices. Hundreds of English pounds were offered for each egg, encouraging fishermen to comb islets for the last of the nesting birds. The only remaining birds known to survive were killed on Eldey Island off southwest Iceland on June 2, 1844; three Icelandic fishermen who discovered two birds, a breeding pair with a single egg, strangled the adults and threw them into a boat (Birkhead 1994). These last great auks were killed for their skins, which were sold to a dealer (Birkhead 1994).

Other marine creatures barely avoided extinction during the period of unregulated killing of wildlife that began in the 1600s. The Atlantic walrus (*Odobenus rosmarus rosmarus*) herd off the Canadian coast numbered at least a quarter of a million animals prior to European exploitation. Between 1633 and 1642, vessels from the Massachusetts Bay Colony made a number of expeditions to Sable Island off Nova Scotia to kill the walruses for their tusks and oil. Glover Allen (1942), in *Extinct and Vanishing Mammals of the Western Hemisphere*, chronicles one sealing voyage in 1641 in which 12 men who spent eight months on Sable Island returned with "400 pair of sea horse teeth, which were esteemed and worth 300 pounds." The walrus colonies in the Gulf of St. Lawrence numbered seven or eight thousand at that time; they were killed off by American sealers, who worked at night while the walruses slept on land (Allen 1942). Gradually, the Atlantic walrus became exterminated in all areas on the continent. From 1925 to 1931, the last large population in the Canadian Arctic on Baffin Island was devastated by the killing of 175 thousand animals (Nowak 1999). Although finally given protection, the species has not shown a substantial recovery because of the high kill by native peoples, which equals annual recruitment in the western Atlantic (Nowak 1999). Only 25 thousand walruses remain in this region. Russia classifies the species as vulnerable and the population in the Laptev Sea as rare (Nowak 1999). They may have increased somewhat along the coast of Norway, in the Svalbard region and Barents Sea (Nowak 1999).

Although the Pacific gray whale has now recovered from near•extinction from whaling, few people are aware that this species once lived in the Atlantic as well (Allen 1942, Mowat 1981). Large numbers of Atlantic gray whales migrated along North America's eastern coast until as late as the end of the 18th century (Mowat 1981). Whalers of the 1740s saw whales whose descriptions matched those of the gray whale, but the existence of this species was not verified until fossil remains were uncovered (Allen 1942, Mowat 1981). Early Basque whalers had eliminated gray whales from European waters centuries before (Mowat 1981). Atlantic gray whales swam south along the shore of the coasts of Maine, Massachusetts and Long Island, down to the Florida Keys, where their calves were born (Mowat 1981). This whale, known as the "Scrag" in the Northeast, was a familiar species off the coasts of Nova Scotia and Maine in early colonial times. It gave rise to place names such as the Scrag Islands, Scrag Rocks and Scrag Harbor Œ now known as Sag Harbor (Mowat 1981). These whales fed in shallow bays on abundant bottom•dwelling crustaceans, making them easy prey for whalers. They were killed beginning in the early 1600s by harpooners off Nantucket Island, Cape Cod and Long Island Sound in the shallow shoals of their migration route (Mowat 1981). By the early 1700s, New England whalers had completely eliminated this whale (Mowat 1981).

Beginning in 1609, Samuel de Champlain sailed down the St. Lawrence River to the Great Lakes (Peck 1990). Other explorers and settlers established trading posts and villages. Furs were major items of trade, and soon beaver and other furbearers were traded in the millions by the French and English. Early travelers found wild turkeys (*Melagris gallopavo*) so abundant boys threw stones at them for recreation (Peck 1990). Two French explorers observed great numbers of fish in the Great Lakes and the upper Mississippi River, which soon became exploited. Vast numbers of cisco, members of the Salmonidae family, once lived in the Great Lakes. The Blackfin Cisco (*Coregonus nigripinnus*) and Deepwater Cisco (*Coregonus johannae*), native to Lake Michigan and Lake Huron, were considered "jumbo herring" by fishermen from early times (Day 1981). By the late 19th century, large fishing vessels with huge nets caught up to 15 million tons from one lake alone per year; one net haul might yield as much as 10 tons in a day (Day 1981). Fishing continued, even in winter, through ice holes, and prior to the availability of freezing facilities, dumping of unsold catches amounted to many tons (Day 1981). These fish became commercially extinct after World War I, and subsequently were declared extinct by the World Conservation Union, along with another Great Lakes species, the longjaw cisco (*Coregonus alpenae*) (Baillie and Groombridge 1996).

This overfishing was repeated in the Atlantic waters off New England and southern Canada. Cod, halibut and flounder abounded here, providing ample fish for centuries to local fishing communities. Huge cod weighing 180 pounds and halibut the size of barn doors were often caught in these times. Factory fishing ships began fishing here in the 1950s and soon depleted the stocks. National legislation banned these vessels from the Atlantic coast and smaller vessels took their place. With few restrictions on take Š and far too many fishermen Š the stocks crashed in the 1980s and early 1990s. With the encouragement of the National Marine Fisheries Service (NMFS), fishermen turned to small sharks known as dogfish. Within a few years, they also became depleted because of their extremely slow reproductive rate, a fact apparently not appreciated by the NMFS. Fishery conservation legislation has been enacted, but these stocks may never return to former abundance.

Some fisherman are being compensated for their boats by a federal program, in order to ease fishing pressure on remaining stocks, but others are turning to small fish, such as menhaden. These fish are fed on by humpback whales (*Megaptera novaeangliae*), threatened species not yet recovered from past whaling, as well as by puffins and other seabirds. Many seabirds are undergoing population decline as a result of a dwindling food supply and the drowning risk posed by fishing nets. Shorebirds, too, are affected by overfishing. Horseshoe crabs (*Limulus polyphemus*) lay their eggs along the east coast each year, providing abundant food for shorebirds on their northward migration, and for many types of other wildlife as well. These crabs are captured by the millions for use as fish bait, which has reduced their numbers dangerously in some areas. The shorebirds have also declined precipitously in recent years, some species by 90 percent. Entire food chains are being disrupted as a result of over exploitation of the sea. Ocean pollution has contaminated Atlantic coastal waters, causing die-offs of dolphins, fish and manatees.

All along the East Coast, colonists built cities at river deltas, which were surrounded by vast salt marshes. These locations were considered prime seaport and manufacturing sites, and the marshes were filled in and polluted. Tens of thousands more acres of marshes along the Northeast coast have been ruined by construction of drainage ditches to control mosquitoes and halt malaria. In fact, these ditches created habitat for mosquito breeding and caused the water level in the marshes to drop. Waterbird populations declined sharply as a result, and they no longer filled their role as fish and shellfish nurseries, water filterers and flood controls. In a recent development, dikes in 10 thousand acres of marshes on Long Island are being blocked to open normal flow channels between marsh and bay, and exotic reeds are being removed (Lambert 1997). The marshes that have been returned to their natural state showed an immediate tripling in the number of waterfowl wintering there, and a doubling of wading birds such as ibis, egrets and herons; shorebird populations quintupled; these marshes have at least 130 species of breeding birds, and 300 species use them for wintering or migration (Lambert 1997). The marshes give a glimpse of the wealth of wildlife that once inhabited eastern coasts; with similar programs, they can be restored to help build up stock of fish and shellfish.

In most areas, however, housing and development now occupy the sand dunes and former marshes. Some barrier islands off the coasts, which buffer the beaches against the erosion effects of storms, have been preserved in portions of the East Coast, such as Virginia, North Carolina and Georgia. Elsewhere, roads, houses and businesses clutter these islands, and development has endangered many native birds. Georgia's beautiful coastal marshes were given official protection after they were nearly destroyed by phosphate mining, when it was shown that their value as shrimp and fish nurseries far outweighed their short-term value for phosphate.

At the southern tip of the United States, the Florida Everglades, one of the largest wetlands in the world, once provided nesting and feeding ground for millions of egrets, herons, pelicans and other waterbirds. This sawgrass wilderness sheltered vast numbers of American alligators (*Alligator mississipiensis*). Cougars, known as Florida panthers (*Felis concolor coryi*), were common, and preyed on the small Everglades white-tailed deer. Water diversion projects for agriculture and the new human population of Miami and coastal cities resulted in a drying out of the Everglades. Exotic plants have proliferated in the marshes, overwhelming the native grasses and choking waterways. Ninety percent of the populations of waterbirds disappeared. The Florida panther recently became extinct in Everglades National Park, one of its last refuges. The alligator has recovered from nearly disastrous hide hunting in Florida, but remains rare in many parts of its original range. A project to restore some of the waterflow to the Everglades was enacted into law in the 1990s (see Aquatic Ecosystems chapter).

The American crocodile (*Crocodylus acutus*), a saltwater species inhabiting coastal areas, was once numerous in Florida Bay and in the mangroves of the Keys. Today, this is one of the most endangered species in the country, numbering fewer than 400 animals. Early hide hunting reduced them and, in this century, pollution and loss of mangroves in their habitat have pushed this species close to extinction.

Many Everglades bird species are also endangered, and one has recently become extinct Š the dusky seaside sparrow (*Melospiza maritima nigriscens*). This sparrow, with its unusually dark coloration, was a victim of the massive destruction of wetlands in Florida. By the time it received the protection of the US Endangered Species Act, this subspecies was nearly extinct. Its limited habitat of spartina grass on Florida's central Atlantic coast had been flooded for mosquito control and drained for the construction of nearby NASA facilities (Ehrlich *et al*. 1992). In an 11th-hour attempt to save these little sparrows, a captive breeding program was set up, mating them with a related subspecies to preserve some of their genes. The last purebred dusky seaside sparrow died at the age of 13 in 1987 (Ehrlich *et al*. 1992). The breeding program was not successful, and by 1997, the related subspecies had also become endangered.

Two spectacular waterbirds, the American flamingo (*Phoenicopterus ruber*), and the scarlet ibis (*Guara rubra*), were once residents of south Florida. Both species were eliminated in the 19th century when, as William T. Hornaday (1913) observed, they "attracted the evil eyes of the 'milliner's taxidermists.'" The feather trade of the late 19th century nearly exterminated the majority of North America's wading birds and many of its seabirds through unregulated slaughter for plumes to adorn ladies' hats. Egrets, roseate spoonbills, herons, terns and other birds with long or colorful feathers were killed indiscriminately. In 1900, the Lacey Act and state laws extended protection to these birds by banning sale and interstate commerce, and the Migratory Bird Treaty Act, signed with Canada in 1918, protected native North American non•game birds from capture, killing and sale.

The Eastern Forests

Ancient hardwood forests stretched for thousands of square miles in eastern North America. Massive oaks, chestnuts, hickories, walnuts and beech trees dominated, some reaching heights of more than 100 feet, with trunks 20 or more feet in circumference. Giant hemlocks and many kinds of pine dominated some areas. The passenger pigeon was the most abundant denizen of these forests, and its range extended from southern Canada, New England and the Great Lakes west to the Great Plains and south to Virginia. The slim bird was somewhat smaller than the familiar rock dove or common pigeon found in cities worldwide, with a long, pointed tail. The male's plumage was beautiful; his back, wings and head were bluish•gray with black streaks and spots, which contrasted with a rich, pinkish tinge on his lower throat. His breast feathers became paler on the belly, and a patch of pink or purple•pink iridescence shone at his neck. His eyes were bright red surrounded by purplish skin, and his legs and feet were red (Goodwin 1983). The female was a duller version of the male, browner gray above, light gray on the breast, with a smaller iridescent pink patch on the neck, more profuse black spots on the wings and gray skin surrounding her orange eyes (Goodwin 1983).

This is the only pigeon Š living or extinct Š that flocked and nested in vast numbers, darkening the sky during their migrations. When Europeans first encountered passenger pigeons, they were dumbfounded by their numbers. One immigrant, Pehr Kalm, described their passage in the spring of 1749: "on the 11th, 12th, 15th, 16th, 17th, 18th and 22nd of March . . . there came from the north an incredible multitude of these pigeons to Pennsylvania and New Jersey. Their number, while in flight, extended three or four English miles in length, and more than one such mile in breadth, and they flew so closely together that the sky and the sun were obscured by them, the daylight becoming sensibly diminished by their shadow" (Fuller 1987). When the pigeons landed on trees, their weight was sometimes

so great that not only would large limbs break off, but entire trees would topple. Prior to settlement of the continent by Europeans, as many as 5 *billion* birds inhabited Kentucky, Ohio and Indiana alone (Blaugrund and Stebbins 1993).

Passenger pigeons were migratory, as their scientific name, *Ectopistes migratorius*, suggested, but not in the manner of most birds, who migrate from an ancestral nesting area to an ancestral wintering area. Instead, immense columns of birds flew as a unit at speeds estimated as high as 60 miles per hour in wide areas in search of nut trees and seeds. John James Audubon, famed illustrator of American birds, described flights in the 1830s that covered the sky for days in some areas, while in other years, none would be seen in the same area (Blaugrund and Stebbins 1993). The forests that once stretched nearly unbroken across eastern North America were crucial to the survival of the passenger pigeon flocks. Nut trees (oaks, hickories and beeches) produced large crops only every few years. In order to locate adequate feeding supplies, the pigeons covered great distances.

John James Audubon visited a roost in Kentucky accompanied by some pigeon hunters in 1831:

Many trees two feet in diameter, I observed, were broken off at no great distance from the ground; and the branches of many of the largest and tallest had given way, as if the forest had been swept by a tornado. Every thing proved to me that the number of birds resorting to this part of the forest must be immense beyond conception . . . Suddenly there burst forth a general cry of 'Here they come!' The noise which they made, though yet distant, reminded me of a hard gale at sea passing through the rigging of a close•reefed vessel. I felt a current of air that surprised me. Thousands were soon knocked down by the pole men. The birds continued to pour in . . . The pigeons, arriving by thousands, alighted everywhere, one above another, until solid masses as large as hogsheads, were formed on the branches all round. Here and there the perches gave way under the weight with a crash, and falling to the ground, destroyed hundreds of the birds beneath, forcing down the dense groups with which every stick was loaded. It was a scene of uproar and confusion. I found it quite useless to speak, or even to shout to those persons who were nearest to me. Even the reports of the guns were seldom heard, and I was made aware of the firing only by seeing the shooters reloading (Schorger 1973).

Once they located a forest with abundant food, they nested in huge aggregations. One colony in Wisconsin was estimated to cover more than 750 square miles, with 136 million nesting birds (Wilcove 1991). Audubon wrote of their courtship, "the tenderness and affection displayed by these birds toward their mates are in the highest degree" and painted two birds "billing" for his *Birds of America* series (Blaugrund and Stebbins 1993). Some described their courtship songs as a series of bell•like notes (Fuller 1987).

Their nests, constructed of loose sticks, held their single white egg. A tree could hold many nests, which the birds placed on strong branches close to the trunk. The flocks rarely nested in the same area two years running, and dispersed as soon as nesting was over; this may have been to prevent natural predators from increasing enough to have a serious impact on their numbers (Wilcove 1991). Also, their food supply tended to be abundant only every few years in a given area. These great colonies made easy targets for legions of meat and market hunters, beginning in the 1600s. By the 18th century, naturalists began to observe that nesting colonies were disappearing; the last great nesting in New England took place near Lunenburg, Massachusetts, in 1851 (Wilcove 1991). By the 1860s, the large flocks had been hunted out of coastal New York State and Pennsylvania. The few laws that were enacted to protect them in the Northeast were not enforced (Wilcove 1991). Season after season, pigeon hunters killed millions of these birds, destroying one colony after another.

Neltje Blanchan, in the 1904 book *Birds That Hunt and Are Hunted*, documented that unlimited netting, even during the nesting season, had resulted in sending more than 1 million pigeons to market from a single roost at the height of the hunting; an equal number of birds were wounded or left starving, helpless, naked chicks behind. Hunters shipped 100 thousand pounds of pigeons to market from a nesting colony near Grand Rapids, Michigan (Wilcove 1991). Audubon and other observers of the time described the brutal hunting methods: young birds were knocked out of their nests with poles, and captive pigeons, whose eyelids had been sewn shut, were tethered to lure wild pigeons to

the ground where they were netted (Wilcove 1991). Nesting trees were cut down or set afire, and sulphur was burned under nesting trees to kill the birds (Wilcove 1991). Blanchan (1904) described the glut of pigeons at markets as so great that the price per barrel scarcely paid for their transportation. The pigeon meat was often fed to hogs.

By the late 1800s, it had become evident to some that the killing was having a disastrous effect on the passenger pigeons. The warnings went unheeded, however. In Ohio, a bill submitted in 1857 to protect the passenger pigeon received the following report from a Select Committee of the Senate: "The passenger pigeon needs no protection. Wonderfully prolific, having the vast forests of the North as its breeding grounds, traveling hundreds of miles in search of food, it is here to•day and elsewhere to•morrow, and no ordinary destruction can lessen them, or be missed from the myriads that are yearly produced" (Hornaday 1913).

The final and precipitous decline of passenger pigeons began in the 1870s, a decade which began with some large flocks still attempting to nest in the Great Lakes area. In 1878, naturalists estimated that some 50 million pigeons survived, but with continued heavy hunting, only one large nesting colony in Wisconsin remained in 1887 (Wilcove 1991). This colony dispersed within two weeks after beginning to nest when hunters began shooting at them (Wilcove 1991). By the 1890s, only scattered individual pigeons Œ who were apparently unable to breed or forage successfully Œ remained. In 1892, one observer noted, "The extermination of the passenger pigeon has progressed so rapidly during the past twenty years that it looks now as if their total extermination might be accomplished within the present century" (Blanchan 1904). This statement proved correct. The incredible wildlife spectacle that flights of billions of passenger pigeons presented, ended completely on March 24, 1900, when the last wild bird was killed in Pike County, Ohio (Wilcove 1991).

The reason for the sudden crash in passenger pigeon numbers has been the subject of controversy in the years since. Two ornithologists from the University of Minnesota, David E. Blockstein and Harrison B. Tordoff, believe during the last 20 years prior to its wild extinction, hunters were able to disturb or destroy virtually every nesting colony. Each year, the adult birds that were able to escape previous hunting and attempt breeding were harassed or chased off the nest, or their fledglings were killed (Wilcove 1991). The adults not killed were relatively long-lived, averaging a lifespan of about 20 years, but because their numbers were not replaced by succeeding generations, when they died off, the species became extinct (Wilcove 1991). Blockstein and Tordoff noted some Passenger Pigeons nested in small groups, escaping the attention of hunters, but they conjectured that without the protection provided by large colonies, these birds rarely succeeded in producing fledgling chicks, and were easy targets for predators (Wilcove 1991). This explanation seems logical, and clearly, the birds were unable to survive in small, scattered groups, dependent on a large colony for successful reproduction. Other factors may also have entered in. It may be that only in the presence of large numbers of their own kind was instinctive breeding behavior stimulated.

A captive passenger pigeon named Martha, about 29-years-old and the last of her species, died at 1 p.m. on September 1, 1914 at the Cincinnati Zoological Gardens. This is perhaps the only species for which the exact minute of its extinction is known (Fuller 1987).

Logging and settlement of the eastern hardwood forests destroyed forever the ancient habitat of these lovely pigeons. Even if the passenger pigeon was somehow recreated, the huge expanses of nut and seed-bearing trees it required have since been cut. More than 99 percent of virgin woodland in the East has been logged, first by settlers, and later by commercial loggers. The colonists of New England, after destroying the forests, found farming the rocky soil difficult and unproductive. The short growing season, often interrupted by frosts, further limited agriculture there. Most of these farms were abandoned, and today, second-growth forest covers the region. However, it is composed of different species of trees than the original old-growth forest and is far poorer in wildlife.

The American chestnut (*Castanea dentata*) once comprised a third of eastern hardwood forests; a huge tree 100 feet tall with a spreading canopy, it had girths up to 12 feet (Jonas 1993) and produced bountiful crops of chestnuts. American chestnuts grew east of the Mississippi River from Maine south to Georgia. Of the 12 species of chestnut trees worldwide, the American was known for yielding the tastiest nuts (Jonas 1993). After heavy logging, older trees

became confined to wilderness areas and towns, where they were greatly admired as shade trees. In 1904, the spores of a fungus known as chestnut blight were accidentally introduced to the country, probably on seedlings of imported Chinese chestnut trees (Jonas 1993). The blight destroyed the remaining chestnuts in the eastern forests, leaving only stumps. These stumps still sprout shoots that grow up to 20 feet until they, too, succumb to the blight (Jonas 1993). Only a few unblighted American chestnut trees remain in the country. On the West Coast, a small number of the trees were planted out of their natural range, and the blight did not reach them (Jonas 1993). Progress is being made in breeding disease-resistant strains of this tree (see Forests chapter and Projects section).

Another eastern hardwood, the stately American elm (*Ulmus americana*), which reaches heights of 60 to 120 feet, has a slim, straight trunk and a broad, graceful crown. It is also nearly extinct; it was attacked by a fungal infection known as Dutch elm disease, which is gradually killing off these trees. First seen in 1930, the disease spread west. It is still in the process of eliminating trees throughout their range in North America from Nova Scotia to Saskatchewan, south to Florida and west to Texas (Jonas 1993). A disease-resistant strain of this tree has also been bred, and the trees are being distributed for free by a nonprofit organization (see Forests chapter and Projects section).

American beeches (*Fagus grandifolia*) were perhaps the most important food tree for wildlife, producing massive amounts of beech nuts on which passenger pigeons, wild turkeys, black bears and other wildlife fed. At 50 to 70 feet tall, beeches have short, wide trunks that begin branching 10 feet from the ground and form enormous, wide crowns (Jonas 1993). The species is still fairly widespread, but old American beeches, which can live 400 years and grow to enormous girths, are extremely rare in woodland settings where they have been logged out.

Ironically, the colonists could have lived well off the land they found if they had not destroyed both the forests and much of the wildlife within a few centuries. The abundant nuts produced by hardwoods, which had nourished the passenger pigeons, also provided food to Native Americans. Many tribes had learned to remove the tannin from acorns so it could be ground into nutritious high-protein flour. Beechnuts, chestnuts, walnuts, hickory nuts, wild fruits and seeds provided excellent food for people as well as wildlife.

European settlers destroyed this rich ecosystem by commercializing the resources, turning ancient forests into short-term logging profits and wild birds, deer and furbearers into commodities. Had another road been taken, the natural environment would have endured with ample resources for all to live on. Many native tribes had cleared some forests for agriculture, but the vast majority remained in their natural state. Settlers, later supported by government policy, claimed ownership of the East and then proceeded to oust native peoples or relegate them to tiny reservations. This resulted in the killing of hundreds of thousands of natives and the extinction of many tribes.

The new Americans, in adopting the European approach to nature, tamed the wilderness and began a program of eliminating natural predators. They considered the reverence with which Native Americans had treated all living things to be a weakness. At the time of European colonization in the 17th century, almost no natural forests remained in Western Europe. Large predators had been eliminated from most of Western Europe, and most wildlife had been crowded out, killed off or confined to private estates where the animals were considered the property of landowners, providing food and sport to the upper classes. Moreover, this wildlife was hardly wild, but semi-tame. Deer lacked predators, the woods on estates were stocked with game birds and the streams with salmon and trout by gamekeepers. The vast majority of European settlers came from the lower and middle classes; they had previously been denied the right to hunt and were eager to do so with abandon. This was another motivation for the relentless slaughter that decimated wildlife during this period.

Benjamin Franklin hoped to make the wild turkey the official symbol of the United States. When colonists arrived, the species was abundant in eastern forests. Uncontrolled hunting and the cutting of forests eliminated these birds from state after state: Connecticut by 1813, Massachusetts by 1851, New York in the mid•1800s, South Dakota by 1875, Ohio by 1880, Wisconsin by 1881, Michigan by 1897, Illinois by 1903, and Iowa by 1907 (Burger 1978, Peters and Lovejoy 1990). Fortunately, the species was not destroyed altogether, and it has been reintroduced into many parts of its original range through transplants from remnant populations.

Once the eastern forests echoed with the howls of gray wolves (*Canis lupus*), common throughout the continent except the Southeast, where the smaller red wolf (*Canis rufus*) roamed. Both these wolves were deliberately persecuted into extinction by colonists who placed bounties on their heads, effectively eliminating them from the wild in the eastern United States prior to the 20th century (see Persecution and Hunting chapter). Seven races of the gray wolf are now extinct, bountied and poisoned by settlers. Around 1911, the Newfoundland race, *Canis lupus beothucus*, was the first to become extinct. This pure white, large wolf had a scientific name inspired by the Beothuk Indian tribe of Newfoundland; both the wolf and the tribe were exterminated by Europeans (Day 1981).

The red wolf became extinct in the wild in the 1970s, after centuries of persecution and habitat loss. Two subspecies, the Florida black wolf (*Canis rufus floridanus*) and the Texas red wolf (*Canis rufus rufus*), are extinct, and only one race survives. The last members of the species were taken into captivity and bred successfully. A reintroduction program in portions of its original range has brought the species back, and about 100 red wolves now live in the wild. The cruelty with which the gray wolf was eliminated is described in detail in the Persecution and Hunting chapter. Another predator once common in these forests north of Florida was the Eastern cougar (*Felis concolor couguar*). It was also bountied and hunted until it became extinct throughout the eastern United States.

In the northern woods, eastern subspecies of the American bison, elk, caribou, moose and white•tailed deer were extremely common. The hunting by Native Americans armed with bows and arrows did not, apparently, cause declines. The guns brought by Europeans, however, decimated their numbers. An unrestricted slaughter of these ungulates went on for centuries. The white-tailed deer became endangered, disappearing from the eastern forests, first from the vicinity of towns and habitations, then from wilderness areas. The other ungulates died out altogether in New England and the middle Atlantic area. The Eastern elk (*Cervus elaphus canadensis*) became extinct. One cause for the disappearance of this huge member of the deer family was hunting to obtain its teeth, which a private organization, the Fraternal Order of the Elks, used as watch•chain insignia (Day 1981). Not only were these animals hunted for food and sale in meat markets by the colonists, but an active export trade in deer and elk skins sprang up. Records show an average of 100,000 of these skins exported to England each year between 1778 and 1808 (Poland 1892). Several small populations of reintroduced elk inhabit Pennsylvania, North Carolina, Tennessee and Virginia.

Hunting caused the extinction of the Eastern bison (*Bison bison pennsylvanicus*) by 1800. This race of bison was larger than the plains bison and very dark; some of the bulls were coal black with grizzly white hair around the nose and eyes (Allen 1942). The last herd of Eastern bison was slaughtered in Union County, Pennsylvania in the winter of 1799 to 1800, as the animals huddled helplessly in the deep snow; the last individuals of this race were killed near Charleston, West Virginia in 1825 (Allen 1942).

Caribou (*Rangifer tarandus*) and moose (*Alces alces*), native to northern New England and southern Canada, were hunted to extinction in the United States in colonial times, surviving only in Canada (Allen 1942). The white•tailed deer has reoccupied its former range in the northeastern United States and, in fact, these deer have become overpopulated as a result of a lack of natural predators (see Persecution and Hunting chapter). The moose has been reintroduced in recent years to New England and is gradually dispersing southward. Attempts to reintroduce caribou in Maine have failed.

The heath hen (*Tympanuchus cupido cupido*) was another casualty of colonial settlement. This eastern subspecies of the greater prairie chicken, a grouse•like bird, was native to forest edges, grassland and heath in portions of the Northeast, from Massachusetts to Pennsylvania and New Jersey (Greenway 1967). Pursued by market hunters, these birds became a staple food for colonists. Heath hens were so common in Massachusetts in colonial times that Governor Winthrop ordered his servants not to have them served more often than a few times a week (Greenway 1967). By 1830, the last mainland Massachusetts heath hen was shot in the western part of the state. In New York State, a 1791 law banned hunting of these birds during spring and summer, but the law was flouted, and market hunting on Long Island resulted in its extinction there by 1844 (Greenway 1967). Overhunting in New Jersey and Pennsylvania killed off the last birds in these states by the 1860s. The last population of these birds survived on

Martha's Vineyard island off the Massachusetts coast and, although protected from hunting, fire and predation gradually eliminated them by 1932 (Greenway 1967).

The existence of brilliantly colored parakeets flying in large flocks in eastern North America was an unexpected surprise for European colonists settling the country. They had thought such birds lived only in tropical regions. Yet these parakeets obviously had adapted to winter snows and frigid nights. The species was named the Carolina parakeet (*Conuropsis carolinensis*) and had a long, graceful tail and a bright yellow and orange head. Its green wings were tinged with yellow, set off by its overall forest green plumage. Eastern parakeets belonged to the subspecies *Conuropsis carolinensis carolinensis* and ranged from Florida to southern Virginia, while western parakeets, *Conuropsis carolinensis ludovicianus*, had a wide distribution from the Mississippi-Missouri River drainage south to Texas, east to Mississippi and north to western New York State and the Great Lakes region (Forshaw 1989). These birds flew in enormous flocks and may have numbered in the millions prior to European settlement.

Like conures (*Aratinga* genus), native to the Caribbean and Latin America, Carolina parakeets could give away their presence by loud and raucous calling. Because they fed on many types of wild seeds and fruits and were able to endure freezing temperatures, they were among the few species in the parrot family able to survive in harsh climates, with the ability to tolerate temperatures as low as -25 F. (Cokinos 2000). Early travelers in Kansas described the appearance of screaming bands of these parakeets during swirling winter snowstorms; flocks settled in groves of cottonwood and walnut trees, delighting travelers with their vocalizing and dazzling colors (McKinley 1985). Large, hollow trees were among their favorite roosting spots, and flocks of birds would cling to the inside of the trees with their beaks and feet (Forshaw 1989). In early morning, the birds would climb to the top branches of their roosting trees, to the accompaniment of much chattering, and then fly off to feed for several hours. When they saw a fruit or seeding tree, the flock would spiral down until they almost reached the ground, and then rise up to alight on the branches. In the afternoons, they sheltered in groves of trees, often near streams where they drank and bathed (Forshaw 1989).

These parakeets may have been most abundant in the South and the major river valleys of the Midwest. Early naturalists described them perched in huge Bald Cypress trees, their bright plumage contrasting with the pale green, feathery foliage. They would hover and flutter on the tops of these cypresses, extracting the seeds (McKinley 1985). Travelers in the southern hardwood forests and swamps, as well as in pine woods, found them very numerous. In Florida's St. John's River area, where mid-19th century observers saw large flocks, many were killed by plantation owners for food (McKinley 1985).

In Audubon's painting of Carolina Parakeets, these extremely sociable birds are clustered in a tree, feeding on Cockleburs (*Cenchrus tribuloides*), their favorite food (Blaugrund and Stebbins 1993). Only recently have the true colors of this bird, as depicted by Audubon, been revealed by a publication of his original watercolors, which shows their plumage in shades of vivid green, yellow and reddish orange. In the lithographs of previous editions, these colors were drab and dull (Blaugrund and Stebbins 1993).

As their forests were cut and prairies plowed for farms, the parakeets turned to raiding crops and orchards. Flocks would converge on farms at times of harvest, alighting on stacks of grain sheaves. So dense were the perching and feeding birds that they made the stacks look as if "brilliantly colored carpets had been thrown on them," according to Audubon (Forshaw 1989). For these raids on farms, they received "severe retaliations" from farmers; Carolina parakeets were easily approached and never learned to fly away from humans. Farmers would shoot entire flocks, killing 10 or 20 at each discharge (Forshaw 1989). When one was shot, the others refused to leave their wounded or dead flock mate. Audubon described these massacres: "The living birds, as if conscious of the death of their companions, sweep over their bodies, screaming as loud as ever, but still return to the stack to be shot at, until so few remain alive, that the farmer does not consider it worth his while to spend more on ammunition" (Poattie 1940).

Like many members of the parrot family, Carolina parakeets attempted to aid others of their kind who were stricken or threatened by predators. This behavior contributed to their survival in natural conditions, and only the

devastating killing power of guns hastened their extinction. Audubon described procuring a basketful of the parakeets with a few shots in 1831 in order to choose good specimens for drawing the figures for his watercolors of North American birds (Fuller 1987). Thousands more of these parakeets were captured for the pet trade and killed for museum collections. At least 675 of the eastern race alone are found in museums. In the last decades of the 19th century, amateur collectors of specimen birds and their eggs proliferated around the country, and dealers in specimens earned large sums from the sale of rare birds. The rarer the bird, the higher the price paid, further endangering the species. Many birds were killed for specimens by collectors who failed to note the location and date of the killing (McKinley 1985). Molting adults and juvenile birds were thrown out, and the physical appearance of the latter birds remains unrecorded (McKinley 1985). One German taxidermist, August Koch, visited the home of a friend in Florida in 1887 and shot some of these parakeets in the back yard of his host as they fed on mulberries (McKinley 1985). A tree that appeared to be sporting "yellow flowers with red centers," turned out to be a flock of parakeets roosting in the early evening, and he shot two birds for his collection (McKinley 1985). Another hunter was led by a Seminole Indian to a "parakeet tree," a large, hollow cypress tree near Lake Okeechobee in Florida, where he shot "as many specimens as my ammunition would allow" (McKinley 1985).

In spite of the keen interest in the species by scientists, naturalists and members of the public, few observations were made of the behavior of these parakeets while they were still common. Almost nothing is known of their life history, flock movements, breeding seasons, nesting, feeding or ecology (McKinley 1985). It is known, however, that they were long-lived, based on the survival of the last captive specimens, which were at least 32 years old. Although a few bred in captivity, they often abandoned their eggs, and no captive-bred birds survived (Forshaw 1989). In spite of large numbers captured for sale as cage birds, no serious effort was made to perpetuate the species through captive breeding, which might have prevented their extinction.

As early as 1831, Audubon noticed a decline: "Our parakeets are very rapidly diminishing in number; and in some districts, where twenty-five years ago they were plentiful, scarcely any are now to be seen" (Forshaw 1989). Flocks of several hundred had commonly been seen when the country was first settled. Within about 90 years, by the 1880s, they had declined both in range and number, with only small flocks or pairs remaining (Forshaw 1989). Persecution by farmers was a major cause Š and perhaps the most important factor Š in the decline of the Carolina parakeet in the view of parrot ornithologist, Joseph Forshaw (1989). The last flocks sought refuge in the forests and remote swamps of Florida, where collectors and trappers pursued them (Forshaw 1989). Other factors played important roles as well. Thousands were killed for sport or for their feathers to decorate ladies™ hats. Their nesting and roosting trees were cut by settlers and loggers, and their food plants were plowed under by farmers (Cokinos 2000). European honeybees, armed with stingers and introduced by colonists, also may have driven them from their hollow trees as they rapidly spread throughout the country, seeking hive sites (Cokinos 2000). These hollow tree-roosting sites may have been crucial to their survival in cold weather; the birds crowded together side-by-side for warmth. The giant hollow cypresses and sycamores, oaks and other hardwoods in the old-growth forests of the eastern United States, crucial habitat to so many species of wildlife, were among the first trees cut in bottomland swamps and forests.

A few Carolina parakeets survived into the first years of the 20th century, with sightings reported in the Panhandle and the Kissimmee Prairie of north-central Florida (McKinley 1985). The last wild specimen was taken in either 1901 or 1904; the date is still in dispute (Cokinos 2000). A flock of 13 of these birds was seen near Lake Okeechobee, Florida in 1920, and two eminent ornithologists, Alexander Sprunt and Robert Porter Allen, went in search of the last members of the species in 1936. They reported seeing a flock along the Santee River in South Carolina, but the National Audubon Society later dismissed the account (Forshaw 1989). In any case, the area was later destroyed for construction of a power project (Forshaw 1989). No confirmed sightings were made after about 1920, although a black-and-white home movie made in 1937 showed some parakeets in the Okefenokee Swamp of southeastern Georgia that *may* have been of this species (McKinley 1985). Had the Carolina parakeet been accorded legal protection and reserves set aside during the 19th century, this spectacular species would almost certainly still be alive.

A pair of Carolina parakeets kept at the Cincinnati Zoological Gardens Œthe same zoo that housed Martha, the last

passenger pigeon Œ was the last known members of their species. Sixteen of these parakeets were purchased by this zoo in the 1880s for $2.50 per bird (Fuller 1987). Over the years, the birds laid eggs, but none hatched or were even incubated, and gradually they died off until only a pair was left Š cage-mates for 32 years (Fuller 1987). In the late summer of 1917, the female, Lady Jane, died. Incas, the male, became listless after her death, and in February 1918, he died of grief, the keepers claimed (Fuller 1987).

The old-growth pine and mixed hardwood forests of the Southeast, as well as Cuba, were home to a large and noisy bird that may have disappeared. The ivory•billed woodpecker (*Campephilus principalis*), at 18 to 21 inches long, is the largest woodpecker in the United States or Canada and the second largest in the world. Elegant in appearance, both male and female are predominantly black, with stripes of white feathers on both sides of the neck; the lower half of their wings is white, as is the enormous bill for which the species was named (Short 1982). Their drumming on dead tree trunks once reverberated in the forests as they removed strips of bark a foot or more long to uncover beetle larvae. They also drummed as a territorial signal, trumpeted and made a call that sounded like a child™s tin horn. Their vocal repertoire also included a soft call between male and female perched side-by-side while changing places incubating eggs in their high nest holes (Cokinos 2000). Never heard by scientists observing them in the wild, the ivory-billed woodpeckers uttered an extraordinary screech when captured and transported away from their forest, as described by ornithologist and artist Alexander Wilson early in the 19th century (Cokinos 2000). Wounding an adult male to use as a subject for a painting, he was astonished to hear him utter fia loudly reiterated and most piteous note, exactly resembling the violent crying of a young childfl (Cokinos 2000). The bird continued to scream loudly as he was carried in a container to a town nearby, alarming people who took the noise for that of a child. Wilson rented a room where he planned to paint him, and the frantic bird began drumming on the wall, breaking off huge chunks of plaster, and damaged a mahogany table. Although offered food, the distraught bird refused to eat and died within three days (Cokinos 2000).

The ivory-bill's decline came as a result of heavy logging begun in the 18th century, which destroyed millions of acres of old-growth pine and hardwood bottomland forest in the Southeast. Each pair required a territory of at least 6 square miles of mature forest, and as their forest disappeared, ivory-billed woodpeckers became so rare that few were seen after 1900 (Cokinos 2000). Hunting also made inroads into their populations. These birds made large targets and were so conspicuous and noisy that they attracted the attention of meat and sport hunters in the 19th century. At that time, few people walked in the woods without a gun; most people took shots at any large bird or mammal.

Over-collecting of specimens by museums was another factor in the extinction of the ivory-billed woodpecker. Its size, beauty and natural rarity brought museum collectors from around the world to scour forests in the South for the last specimens of this bird. There are 400 known museum specimens worldwide (Day 1981), and most of these were taken in the last years of the 19th century, when the species had become extremely rare. Nineteenth century museum curators often sent collectors out to obtain specimens of very rare animals after they received word that the species was headed toward extinction. Responsible modern natural history museum curators do not routinely collect rare animals, but reach agreements to allow very limited collection of newly discovered species, usually only by the scientist who made the discovery. Most museums now loan specimens to scientists who wish to examine them.

Dr. Lester Short (1982), an authority on woodpeckers, believes the ivory-billed woodpecker's original habitat was probably the virgin pine forests that once covered much of the Southeast. They had become confined to hardwood swamp forests in Louisiana, which was probably not ideal habitat for them (Short 1982). Upon the discovery of a small number of Ivory-bills in a forest along the Tensas River in Louisiana, Cornell University scientists organized an expedition to film and record these birds. They later designated a young Ph.D. ornithologist, James T. Tanner, to study these last birds in the wild. In his study, *The Ivory-billed Woodpecker*, published in 1942, he estimated that at that time, no more than 22 of these woodpeckers remained in the United States. His investigation centered on the only known population of ivory-billed woodpeckers in the 120 square mile old growth forest. The Cornell team filmed the birds drumming on trees and recorded their various calls. This film is part of Stouffer Productions' fiAt the Crossroadsfl film. (See Video section, Endangered Species, General.) These recordings are retained in the Cornell Ornithological Library of bird songs, along with motion pictures of a pair of woodpeckers.

Tanner documented the presence of seven pairs and four young in 1934. He also traveled extensively in the Southeast, where ivory-billed woodpeckers were seen in the past, asking local people for sightings and listening for their unique calls; he was unsuccessful. From 1931 to 1939, the last remaining birds raised 19 young. They declined as he was observing them, however, and by 1939, only six ivory-billed woodpeckers Š one pair, one young bird and three males Š remained in these woodlands (Cokinos 2000). They had lost the majority of their habitat after the Singer Company sold the logging rights for these 80 thousand acres to Chicago Mills in 1937, and the old growth forest was rapidly leveled. Some of the birds may have been shot for the $1,000 collectors were willing to pay (Cokinos 2000). In the early 1940s, the National Audubon Society™s president appealed directly to President Franklin Roosevelt to spare the ivory-bills™ last habitat, and the Secretary of the Interior was ordered to consider the matter (Cokinos 2000). Various federal agencies and the War Production Board agreed these trees could be spared for the war effort. These agencies and four state governors urged Chicago Mills to protect this forest (Cokinos 2000). The State of Louisiana offered the company $200 thousand as compensation in December 1943, but it refused, and attempts in the US Congress to pass legislation to mandate protection of the Singer woodlands failed as well (Cokinos 2000). This company remained indifferent to the fate of the woodpeckers, red wolves, mountain lions, black bears and abundant birdlife being destroyed to produce chests to ship tea to the English Army (Cokinos 2000).

Unknown to conservationists and government agencies was the fact that it was already too late. Richard Pough, a National Audubon Society employee, was sent to search for any remaining ivory-billed woodpeckers in the Singer woodlands in December 1943. He saw the last ivory-billed woodpecker, a lone female, and noted in January 1944: fiIt is sickening to see what a waste a lumber company can make of what was a beautiful forest. Watched them cutting the last stand of the finest sweet gum on Monday. One log was 6 feet in diameter at the buttfl (Cokinos 2000). This may have been the same female and her fledgling chick seen by Tanner in 1941, the only birds remaining at that time (Cokinos 2000). A wildlife artist, Don Eckelberry, heard of the disastrous situation for this species and traveled to the Singer woodlands to paint this female ivory-billed woodpecker. His observations constitute the last authenticated sightings of the species in the United States (Cokinos 2000).

Many searches have been made throughout its once wide range, which extended from southeastern Oklahoma and Missouri north to Indiana and east through northern Florida. Sightings have been made of these birds over the years in Florida and Mississippi, but none was authenticated by photographs or recordings (Cokinos 2000). The last 20th century observation was made on April Fool™s Day, April 1, 1999, by a forestry student along the Louisiana-Mississippi state line, in the Pearl River basin (Cokinos 2000). He claimed to have seen a male and female at close range in a swamp forest (Cokinos 2000). Subsequent searches of this forest by ornithologists and others failed to find any trace of ivory-billed woodpeckers (Cokinos 2000).

There is slim hope that the species might survive either in the United States or in Cuba. These birds were seen in Cuba™s southeastern pine forests during the early 1980s, but this population dwindled and disappeared by 1991 in spite of a reserve that had been set aside for it (Collar *et al.* 1994). In 1998, evidence of its possible survival in Cuba consisted of some likely sightings in the Sierra Maestra highlands, where it had never been seen before (BI 2000; Garrido and Kirkconnell 2000). Although unlikely, it would be a truly exciting event if the magnificent ivory-billed woodpecker survived in spite of the almost total loss of its habitat.

Bachman's warbler (*Vermivora bachmanii*), a small yellow songbird of the southeastern United States, has not been seen for decades. John James Audubon painted a pair of these birds without ever having seen them alive. The species was discovered in 1833 by his close friend, John Bachman (Blaugrund and Stebbins 1993). Audubon's painting was based on specimens sent to him by Bachman. He depicted the Bachman's warbler posed stiffly on a Franklinia tree (*Franklinia altamaha*), an equally mysterious species with large white flowers. Discovered in the South in 1765 by the noted botanists William and John Bartram, this beautiful tree was named in honor of Benjamin Franklin (Blaugrund and Stebbins 1993). In spite of thorough searches in the area in Georgia where the tree was found, the Franklinia was never seen in the wild again (Blaugrund and Stebbins 1993). Fortunately, the Bartrams had taken cuttings of the tree for cultivation, and this tree is now grown in botanical gardens and nurseries throughout the world. Bachman™s warbler became very rare after 1920.

Originally, these warblers ranged from the lower Mississippi River and east Texas, north to southern Indiana, and along the east coast from Georgia north to southern Maryland (Hamel 1995). The species' original habitat was southern bottomland, hardwood forest with extensive cane (*Arundinaria gigantea*) thickets (Hamel 1995). Clearance of these forests in the 19th century and first decades of the 20th century, both in the United States and in Cuba, where it wintered, eliminated the majority of its habitat. It is not known to what extent it used canebrakes and bamboo thickets growing on bottomlands, but these were the last habitats in which it was seen.

A 19th century observer of Bachman's Warblers, O. Widmann, entered bottomland forests in the Mississippi Alluvial Valley, and wrote in 1897, "I had no trouble in finding several singing males on the day of my arrival– In the wildness of his home it takes several minutes to follow him over fallen trees and around impenetrable thickets or pools of water" (Hamel 1995). Widmann saw its nest "tied very slightly to a vertical blackberry vine of fresh growth– From above, it was entirely hidden by branchlets of latest growth– to reach the place it was necessary to go through pools of water and heaps of fallen trees and brush. Such sheltered places are probably chosen to avoid the danger of being trampled down by hogs and cattle roving in these woods" (Hamel 1995). This wild region was a mixed habitat of sweetgum, blackgum, tulip trees, mulberry, ashes, cottonwood, hackberry and hardwoods; Bachman's warblers were seen mainly in the higher portions, which were also those first cleared (Hamel 1995).

Approximately 400 scientific specimens were collected for museums, and this may have reduced its population at a time when it was already rare (Hamel 1995). The last nest was found in 1937, and much of this species' life history remains a mystery. Intensive searches have been carried out by biologists for this bird; a total of 7,000 hours were spent between 1975 and 1979 combing likely habitat areas in South Carolina, Missouri and Arkansas. In 8,000 hectares (19,768 acres) of apparently suitable habitat, no Bachman's warblers were seen or heard (Hamel 1995). As recently as 1980, an unconfirmed sighting was reported in Cuba, but the last confirmed sighting of a Bachman's warbler was in 1961 near Charleston, South Carolina (Hamel 1995). An unconfirmed sighting was made in 1988, but none have been seen since (BI 2000).

Endless Grassland

Stretching more than 1,000 miles from Illinois west to the Rocky Mountains, and from southern Canada south to Texas, the North American Prairie seemed endless. In the Midwest, tallgrass prairie interspersed with oak trees dominated, and farther west, in a north-to-south band, was an immense shortgrass prairie. Through its center flowed the Mississippi and Missouri Rivers, their confluence creating one of the world's greatest rivers. Lining the rivers were hardwood forest swamps from the Mississippi Delta at the Gulf of Mexico north to the Missouri River, where river otters, muskrats, beaver, mink and raccoon abounded. A vast mosaic of wetlands, known as "prairie potholes," dotted the northern Plains states and, during the spring, turned into ponds and marshes, making them perfect breeding areas for millions of waterfowl and shorebirds.

An estimated 50 million American bison (*Bison bison*) thundered across the prairie in a spectacle rivaling the migration of today's East African wildebeests, and far exceeding them in number. While the passenger pigeon may have been the most numerous bird in Earth's history, the bison is considered the most numerous large mammal to ever have lived on the planet. Coexisting with these bison were Plains tribes of Native Americans Š Pawnee, Blackfoot, Crow, Ojibwa, Sioux, Mandan, Comanche and others.

In 1804, President Thomas Jefferson commissioned Meriwether Lewis and William Clark to travel across the newly acquired Louisiana Territory west to the Pacific to conduct the first natural history survey of the American

West. Clark described the prairie near the Missouri River as "rich, covered with grass from 5 to 8 feet high, interspersed with copses of hazel, plums, currents, –raspberries and grapes of different kinds" (Peck 1990). Lewis's journal entry records his awe of the landscape: "Nor do I believe that there is in the universe a similar extent of country. As we passed on, it seemed as if those scenes of visionary enchantment would never end."

Throughout their travels they saw "immense herds of buffalo, deer, elk and antelopes," some "so gentle that we pass near them without appearing to excite any alarm among them" (Peck 1990). Wolves and foxes were common, along with animals they had never seen before Š pronghorn antelope, jackrabbits, prairie dogs, coyotes, grizzly bears and many beautiful prairie birds (Peck 1990). One of the purposes of their journey was to assess the marketable potential of the wildlife, especially furbearers. Their observations paved the way for the fur trade and slaughter of wildlife that effectively eliminated large mammals from the Great Plains by the end of the century.

A visual record of the original prairie was made by various artists, the most famous of which was George Catlin, whose magnificent portraits of the Native Americans, American bison and landscapes preserve them for posterity. It was Catlin who proposed this wild land be protected:

Nature has nowhere presented more beautiful and lovely scenes, than those of the vast prairies of the West; and of man and beast, no nobler specimens than those who inhabit themŠthe Indian and the buffaloŠjoint and original tenants of the soil . . . And what a splendid contemplation too, when one imagines them as they might in future be seen (by some great protecting policy of government) preserved in their pristine beauty and wildlife, in a magnificent park . . . A nation's Park, containing man and beast, in all the wild freshness of their nature's beauty (Peck 1990).

The world's first national park, Yellowstone National Park, was set aside in 1872, protecting some 2 million acres of mixed grassland and forest and the last wild bison in Montana and Wyoming, but Native Americans were excluded. The huge prairie park, as envisioned by Catlin in the central part of the continent, has not been established. It would have been a biological treasure for future generations. A tallgrass prairie national park was established in the 1990s, and perhaps in the future, a large national park will preserve portions of the once vast shortgrass prairie.

The US government encouraged the slaughter of bison as part of a deliberate campaign to vanquish the Plains tribes by removing their means of subsistence; the slaughter was also a free•for•all hunting spree by crews working on the transcontinental railroad after 1830 (Allen 1942). Thousands of bison were killed just for their tongues, which were considered a delicacy. The commercialization of the bison sealed its fate. In 1840, the American Fur Company sent 67,000 robes of bison hides to St. Louis, a fur trading center (Allen 1942). In the upper Missouri country, 250 thousand bison were killed annually until the 1870s; during this decade, just as in the case of the passenger pigeon, the slaughters turned the tide for the species (Allen 1942).

With the completion of the railroad, the great herd became split in half, and migrations that once took them from Montana to Texas were ended by a shooting spree lasting until the late 1880s (Allen 1942). In Dec. 1877 and Jan. 1878, the "last great slaughter" took place on the isolated southern herd of Kansas, Oklahoma and Texas; 100 thousand hides were taken by an army of hunters, wiping out this herd (Allen 1942).

Only the protection of two small herds in Yellowstone National Park and Wood Buffalo National Park in Alberta, Canada, totaling about 541 individual bison, prevented the extinction of the species (Allen 1942). Even the 300 bison in Yellowstone were nearly killed off by poachers between 1890 and 1893; 270 animals were shot illegally, leaving only 30 in the park (Hornaday 1913). These few wild bison stayed as far as possible from tourist routes, and by 1912 the herd had grown to 49 (Hornaday 1913). Since then, herds have been re•established in several parks in the West. There are now more than 150 thousand bison, but the majority is ranched animals, bred for docility. Even these represent a tiny fraction of their former numbers. Pure strains of American bison can be found only in the herds of Yellowstone and Wood Buffalo National Parks.

Other grassland wildlife was slaughtered for the meat trade. Among the millions of shorebirds that migrated through the Great Plains and bred there was a mousy brown, medium•sized bird known as the Eskimo curlew (*Numenius borealis*). These birds were known to many market hunters as "prairie pigeons" or "doughbirds" because of the thick layer of fat the bird added before migration (Ehrlich *et al*. 1992). This bird became the prairie equivalent of the passenger pigeon Œ an ominous comparison that signaled its ultimate fate. Eskimo curlews were once the second most numerous species of wading bird in North America Š numbering in the hundreds of thousands, possibly in the millions. Their destruction was so rapid that nesting and breeding areas were never fully documented. Only a few nests were found in arctic prairies of northwestern Canada between the Mackenzie and the Coppermine Rivers (Greenway 1967), but no one knew whether this was their prime nesting area. Their breeding behavior, number of eggs and chicks and related information remain undocumented.

Eskimo curlews flew in compact flocks and, when landing to rest and feed, were extremely tame and approachable. They were known to eat berries and Rocky Mountain grasshoppers (*Melanoplus spretus*) in burnt areas of prairie grass (BI 2000). This insect later became extinct, and prairies were plowed into agricultural fields (BI 2000). Eskimo curlews™ fall migration along the Atlantic coast through Labrador took them 8,000 miles to winter on the pampas of Argentina, southern Brazil and Chile (BI 2000). They were heavily hunted along the way. On one migration in 1872, three men in Cape Cod and Nantucket killed $300 worth of curlews they sold for 6 cents per bird [5,000 birds] to local meat markets (Hornocker 1913). In the spring, the birds would return through Central America and the Great Plains (Hayman *et al*. 1986). During the spring migration, they again became targets for the hunters. If a flock was shot at, the birds would fly only a short way before landing again, and they often returned to the same spot, resulting in the slaughter of entire flocks (Schreiber *et al*. 1989). The meat market hunters could fire a single shot that would bring down dozens of Eskimo curlews (Peck 1990). This hunting endangered them (Ehrlich *et al*. 1992) and, in spite of a ban on hunting in 1916, no recovery took place (BI 2000).

Their wintering habitat had been plowed as well, beginning in the late 19th century when their pampas in Argentina were used to produce export crops for Russia (Schreiber *et al*. 1989). Their populations plummeted from loss of habitat and unrestricted hunting, and fewer and fewer curlews managed to reach their northern breeding grounds. By the turn of the century, Eskimo curlews had become extremely rare. None has been seen in South America since 1939 (BI 2000). Several birds were shot in Barbados on their southern migration in 1964, and during the 1980s through 1996, various unconfirmed sightings were made (BI 2000). There is little hope that the Eskimo curlew survives.

Dominant among all the prairie predators, the grizzly bear (*Ursus arctos horribilis*) towered more than 10 feet tall when standing upright. Very common on the prairie, these bears ranged over most of western North America, from the Arctic Circle to northern Mexico. They were common in many types of grassland. All the subspecies except *Ursus arctos horribilis* became extinct south of Canada. In spite of its great strength and intelligence, in addition to the difficulty explorers and settlers had in killing it, these great bears were hunted to near extinction. Lacking cover in most of the Great Plains, the bears made large targets as they foraged for their primarily vegetarian diet, and were eliminated here first. Hunters made expeditions to kill these animals, and wrote articles and memoirs of their hunting prowess as they eliminated grizzly bears from one area after another. South of Alaska, only Yellowstone National Park and Glacier National Park harbored grizzly bears by the 1940s (Allen 1942).

Fur trapping intensified in the 19th century, with professional trappers combing the countryside, setting leghold traps and spreading poison to kill the most valuable furbearers such as beaver and river otter. Within a short time, both these animals had disappeared from large parts of the country, including most of the Midwest. The American beaver (*Castor canadensis*) is a keystone species in aquatic environments, creating habitat for otters and other wildlife with their dams. In fact, the range of the river otter in North America nearly coincides with that of the beaver. Trappers killed beavers in their lodges and dynamited dams to scare them into the open until these once common rodents became rare in many parts of the country. Their fur was highly valued and used in the manufacturing of top hats in England and Europe. The relentless trapping wiped these animals out throughout much of the country, and the beaver ponds that once dotted the landscape disappeared, greatly altering ecosystems for the worse. Otter fur was

even more valuable because of its durability and waterproof qualities, and these animals, which had never been abundant, disappeared from two-thirds of their original range south of Canada (Nilsson 1985). River otters play an important role in aquatic ecosystems by culling overpopulated fish populations.

Other predators, such as the gray wolf, the kit (*Vulpes macrotis*) and the swift fox (*Vulpes velox*), were nearly eliminated from the United States south of Alaska. Fur trapping was followed by persecution in the form of predator control programs to benefit livestock ranchers. The gray wolves of the prairie were often white or pale gray and were entirely eliminated here (see Persecution and Hunting chapter).

The fleetest animal in North America nearly became extinct. The pronghorn (*Antilocapra americana*), a species found only on this continent, is not a typical antelope, but the last survivor of a family of ungulates long extinct. Once abundant throughout the Great Plains and in the deserts of the Southwest and Mexico, they may have numbered as many as 40 million animals prior to European settlement (Peters and Lovejoy 1990). Pronghorns travel in herds able to "fairly fly over the ground," in the words of Glover Allen (1942), when fleeing predators. Their natural curiosity, an urge to investigate any unfamiliar object, may have contributed to their near•extinction. One hunter told of luring the pronghorns within gunshot by donning a white sheet and approaching them on all fours (Allen 1942). George Catlin painted natives luring them close by waving a feather on a stick.

By the turn of the century, so many pronghorn had been shot by settlers and meat hunters that the species was reduced to endangered status (Allen 1942). William T. Hornaday, director of the New York Zoological Park and a prominent conservationist who had saved the American bison from extinction in the early part of the century, predicted in 1913: "The Prong•horned Antelope, unique and wonderful, will be one of the first species of North American big game to become totally extinct. We may see this come to pass within twenty years. They cannot be bred in protection, save in very large fenced ranges. They are delicate, capricious and easily upset. They die . . . at the drop of a hat" (Hornaday 1913). Fortunately, his prediction did not come to pass, and total legal protection of the last pronghorns saved the species from extinction. Yellowstone National Park was crucial to the species' survival, and the bison™s as well, by protecting remnant herds. These herds provided the stock from which pronghorns were reintroduced to areas where they had been eliminated (Allen 1942). Today, they are fairly common in the western states of Montana, Wyoming and Colorado and found in smaller numbers in other parts of the West (see Grasslands, Shrublands and Deserts chapter for more on this species).

Another victim of the hunting slaughters of the 19th century was the Badlands bighorn sheep (*Ovis canadensis auduboni*), once numerous in the rugged hill country of the upper Missouri and Little Missouri Rivers in North and South Dakota and parts of Nebraska (Allen 1942). Weighing about 344 pounds, the males had massive curved horns that trophy hunters sought. While they grazed on the prairie near the high buttes, they were ambushed by hunters who cut off their escape. Even President Theodore Roosevelt contributed to their extinction by hunting them in the early 1880s (Allen 1942). The last record of this grayish brown sheep in North Dakota was an old ram killed about 1905, and the dates of extinction of the South Dakota and Nebraska populations are unknown (Allen 1942). Rocky Mountain bighorn sheep, another race of this species, have been reintroduced into the South Dakota Badlands.

Prairie streams and clear•flowing rivers provided habitat for several unique species of fish. The harelip sucker (*Lagochila laura*), whose downturned mouth had a large disk with which it fed on the stream bottoms, became extinct in 1893 when grasslands were plowed and streamsides disturbed; the water became turbid and muddy, causing the fish to literally asphyxiate in the silt•laden water (Day 1981).

Today, the tallgrass prairies have become wheat and corn fields, crisscrossed by highways, and dotted with towns and cities. More than 90 percent of the original prairies are gone (Peters and Lovejoy 1990). Even in the few areas where native grasses were not plowed under, diversity of grass species has declined from 200 to 30 species in most areas because of heavy livestock grazing (Peck 1990). Tallgrass prairie reserves have been established in Wisconsin, Kansas and Oklahoma. In the latter state, a herd of 300 bison was released in the early 1990s in virgin tallgrass prairie in Oklahoma by The Nature Conservancy after an absence of more than 100 years. Many National Grasslands were

established in the range of the shortgrass prairie, primarily for livestock, but after many decades of grazing, rodent and predator control, this land bears little resemblance to the original prairie (see Grasslands, Shrublands and Deserts chapter).

Western Landscapes

In the southwestern United States and northern Mexico, deserts harbor a great wealth of species. The Mojave, Sonoran and Chihuahuan Deserts of the southwest differ from one another in their vegetation, topography and wildlife. All are dotted with deep springs and oases, each having endemic species of fish Œ vestiges from ancient times when seas covered the land. The Sonoran Desert, most verdant of the three, is studded with giant Saguaro cacti (*Sereus giganteus*), more than 60 feet tall and found nowhere else on Earth, along with many other unique and beautiful desert plants. Deer, pronghorn, bighorn sheep and a variety of predators Š from grizzly bears and jaguars to gray wolves and coyotes Š lived in this desert, the most botanically rich in the world. Bird life was also prolific, and desert tortoises sheltered in burrows during the day. Mountain ranges jut from the Chihuahuan Desert to the south, and the Mojave of California is characterized by an extremely hot and arid climate, in which many unusual plants and animals manage to survive.

In southeastern Utah and Nevada, pinyon•juniper vegetation once covered thousands of square miles. The US Department of Interior's Bureau of Land Management has converted millions of acres into shrubland for the benefit of cattle. The pinyon pines, whose nuts have been a source of food for native tribes for thousands of years, have been destroyed in large part by chaining, wherein chains are stretched between two bulldozers, which then drag them across the pine-juniper bushes and trees, uprooting them. This ecosystem is home to desert tortoises and a wide variety of birds and small mammals, but today, the diversity and abundance of wildlife has been greatly diminished.

Much of the deserts are federally owned, and management has been primarily to benefit livestock owners and other users. Portions of the Mojave Desert and more than a million acres of spectacular Utah cliffs and desert have recently been made a National Reserve. These areas will not receive strict protection, however, since oil drilling and other activities, such as livestock grazing, will be allowed.

Streaming through the dry Southwest, the mighty Colorado River carved the vast Grand Canyon in Arizona as the land was thrust up and sunk with movements of the Earth over millions of years of geologic time. Some of the oldest rock formations have been dated at more than 1 billion years. These eons are etched in the Canyon's layered slopes. This canyon is one of the great natural wonders of the world, a wilderness of pastel-hued cliffs and beautiful vistas. Plateaus surrounding the canyon are geographically isolated, and many endemic animals inhabit these pine forests. In the Colorado River's turbid waters, a large number of unique fish evolved. The river has been dammed throughout its course, however, to supply water for irrigation, cities and suburban homes, as well as to generate electricity. One-fourth of the Colorado's water is used to irrigate the crops of California's Imperial Valley. The delta of this once immense river was described in 1922 by the conservationist Aldo Leopard as teeming with wildlife. That same year the Colorado River Pact was signed, which gradually removed its flow. Today the delta in northern Mexico is almost dry. The endemic fish and birds of the Colorado River system have been decimated by these projects. Some are being conserved under US Endangered Species Act programs conducted by the Fish and Wildlife Service. The dams that pepper the river turn the once warm and silty water cold and clear, a new habitat that native fish find intolerable.

The Sonoran Desert's unique and beautiful plant life has declined in the decades since 1970 because of unrestricted development for suburban housing; much of it is for retired persons seeking a dry and sunny climate. New houses, roads and commercial centers are gobbling up tens of thousands of acres, and in the process, the venerable giant

Saguaros and other desert vegetation are bulldozed. These new communities use enormous amounts of water piped from the Colorado River and several diverted desert rivers. These desert oases turned to dust, eliminating their wildlife and plants. One of the few desert-nesting bald eagle populations became extinct as a result of the Central Arizona Project, which diverted water for agriculture and towns. Most residents in the Southwest have eliminated natural desert vegetation and planted grass lawns in front of their homes, which require almost constant watering and heavy use of chemical fertilizers, pesticides and herbicides Œ pollutants of the water table.

Merriam's elk (*Cervus canadensis merriami*) was native to various mountain ranges of southern Arizona and New Mexico. The antlers of this elk were the largest of all the elk races, and the animal was described as more pale and reddish than the Rocky Mountain elk (Allen 1942). Vulnerable because of its restricted range, it was hunted by cattle ranchers in the late 1800s, and crowded out by livestock. The last individuals were killed around 1906 in the Chiricahua Mountains of southeastern Arizona, where they had sought refuge in high altitudes (Allen 1942).

Thousands of elk and bighorn sheep died from diseases brought by domestic cattle. Lacking natural resistance, entire populations died soon after they came into contact with domestic cattle and sheep that carried disease. Native Americans also died by the thousands because of diseases Œ from measles to small pox Œ brought by colonists and settlers. A number of tribes that had inhabited the West for thousands of years became extinct. In some cases, the tribes lost their land and dwindled to extinction.

West of the Rocky Mountains an unbelievably rich and beautiful land awaited settlers. The Sacramento and San Joaquin Rivers flow through the huge Central Valley, an area covering thousands of square miles. Prior to settlement, breathtaking vistas of wildflowers and grasslands grazed by innumerable elk and mule deer were framed by distant snowy mountains. The largest lake west of the Mississippi River, Lake Tulare, covered much of this river valley. Shallow and seasonal, this lake swelled after spring rains to serve as a breeding ground for an estimated 100 million waterfowl. Early naturalists spoke of the birds darkening the sky for days.

Spanish colonists established vast cattle ranches, beginning in the 1600s in what is now California. After Mexico lost this territory at the end of the Mexican War in 1848, American settlers poured into the region and agriculture began on a grand scale. In the late 1800s, California became thickly settled. The grasslands, deer, elk and the distinctive California grizzly bears that roamed California's valleys were eliminated by hunting and habitat destruction. The grizzly bears, still pictured on California's flag, were hunted to extinction (Nowak 1999). The Central Valley soon became California's bread basket, with agriculture displacing the tule elk (*Cervus canadensis nannodes*), whose range once extended throughout the San Joaquin and Sacramento Valleys, half the length of the state. As a result of hunting and loss of its habitat, the small herds of remaining elk became confined to a tule marsh area near Tulare Lake (Allen 1942). Transplants to other areas have not succeeded, and this subspecies remains very rare. Ninety•five percent of the wetlands of California's Central Valley and marshes that once dotted the coastline have been filled in for farms and development. Tulare Lake and its millions of ducks disappeared completely from drainage and water pumping, becoming the world's largest artificial farm, irrigated by water piped from elsewhere in the state. The Central Valley Project, an immense system of ditches, canals and pipelines, pumped water from the rivers in the Sierra Nevada Mountains to supply Los Angeles with water, devastating salmon and other wildlife. The Sacramento River once had an estimated 2 million salmon, and a fishery, but today they are nearly extinct as a result of the water diversion and dams.

California has incurred the greatest loss of wetlands of any state. Damming and diking of waterways to divert water for irrigation in the Central Valley resulted in the extinction of a foot•long fish once caught for the fish markets of San Francisco. The thicktail chub (*Gila crassicauda*) was very common until the 1880s, but by the 1920s, it had been driven to extinction (Day 1981). San Francisco Bay, the largest wetland and estuary on the West Coast, has been greatly altered by water diversion projects and drainage for agriculture and building. The bay has a great number of endemic species and races of birds and fish, and many of these have disappeared or become extremely rare. Federal protection under the US Endangered Species Act for many of these species may prevent their extinction.

North America's largest bird, the California condor (*Gymnogyps californianus*), soared over coasts and inland valleys Œ as far north as Washington State. This bird came close to extinction as a result of hunting and accidental poisoning (see Persecution and Hunting chapter). The last wild birds were captured for captive breeding, and young birds have been released to the wild. It will be years before it is known whether this giant vulture will survive and breed in the wild. In the foothills of the Sierras grew thousands of immense sequoias (*Sequoia gigantea*), trees that can live for more than 4,000 years. At a height of up to 300 feet tall, these trees attain a girth of 100 feet and support wood weighing 600 tons, making them the most massive and heaviest organisms that have ever lived (Jonas 1993). Sequoias take 3,000 years to attain full growth, sprouting from a seed only a quarter inch long. These trees were logged, reducing them greatly until they received legal protection. Sequoia National Forest was declared a National Monument by President Bill Clinton in 2000 to stop logging of other types of trees in the forest, which was threatening the root systems and survival of these ancient Sequoias. It is now illegal to cut a Sequoia.

In northern California, Oregon and Washington, ancient forests of hemlocks, pines, cedars and coast redwoods (*Sequoia sempervirens*) had grown undisturbed for thousands of years. Redwoods are the tallest trees on Earth, reaching heights of more than 365 feet and measuring up to 58 feet in circumference (Jonas 1993). These forests once lined 2,000 miles of Pacific coastal region from northern California through British Columbia, ending in southeastern Alaska, covering 70 thousand square miles. Centuries of logging have reduced these forests to only about 5 percent of their former size in the United States, and less than 40 percent in Canada (Middleton 1992). Commercial logging began in the 19th century and has proceeded throughout this century, clear cutting millions of acres of redwoods, Douglas Fir and other evergreens in forests, cutting in a few hours trees that took a thousand or more years to grow. Once cut, these forests need hundreds Š if not thousands Š of years to regenerate to their former biological richness. The land where these forests once stood has been converted to other uses, precluding their regrowth.
Loggers are still fighting conservationists over the fate of the last five percent of Pacific Northwest old-growth forests and their endangered residents (see Forests chapter). Although the sequoias and coast redwoods have escaped extinction, they are far rarer than they once were, and the redwoods continue to be cut to be made into lawn furniture and decks.

A race of bison native to these forests, the Oregon bison (*Bison bison oregonus*), was distinct in being slightly larger than the Plains bison, with longer and straighter horns (Allen 1942). Once native to southern Idaho, northern Nevada to southeastern Oregon and northeastern California, they died out soon after the arrival of the early explorers. Although the history is unclear, tales from the Native Americans indicate that arms supplied to them by explorers were used to hunt these animals to extinction by the mid•1800s (Allen 1942).

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Wetland Drainage: Page 2

Thousands of years of drainage, pollution, diversion and overuse of the rivers and wetlands in the Middle East have destroyed once verdant areas such as the site of ancient Babylon in present-day Iraq. The single exception, until recently, was the 6,000-square-mile delta of reeds, lagoons and marsh south of the confluence of the Tigris and Euphrates Rivers on the Persian Gulf in Iraq. This wilderness maze was inhabited by the reed homes of the Shiite

marsh Arabs (Hedges 1993). They fished from small boats woven from marsh plants, a lifestyle unchanged for thousands of years (Dugan 1993). After the 1989 Persian Gulf War, Iraq's President Saddam Hussein ordered that the swamps be drained to vanquish the Shiites, who had opposed his government (Hedges 1993, Lewis 1993). The Iraqi portion of these marshes has also been polluted by oil spillage from the war. Within a few years, approximately 90 percent of these ancient wetlands were drained and soon dried out in the desert sun. Observers flying in small aircraft have documented that these wetlands now resemble dusty fields.

The best known animal resident of Iraq's marshes may be Maxwell's otter (*Lutra perspicillata maxwellii*), named for the charming otter who inspired the story *Ring of Bright Water*, by Gavin Maxwell (1961). This male otter had been captured in these marshes and brought by the author to the British Isles after many misadventures in trains and hotel rooms. When examined by zoologists, he was determined to be an endemic and distinct race of the smooth-coated otter. The fate of Maxwell's otters may not be learned for many years to come. Other victims of the destruction of Mesopotamian marshes may be the birdlife: several million waterfowl wintered in the wetland (BI 1993). Endangered and rare birds that winter here include the dalmatian pelican, pygmy cormorant (*Phalacrocorax pygmaeus*), marbled teal (*Marmaronetta angustirostris*), white-tailed eagle (*Haliaeetus albicilla*), imperial eagle (Aquila heliaca) and slender-billed curlew (*Numenius tenuirostris*), according to BirdLife International (1993). Two endemic breeding birds are also at great risk. The Iraq babbler (*Turdoides altirostis*) and the Basra reed warbler (*Acrocephalus griseldis*) are restricted to these marshes in southeastern Iraq and adjoining southwestern Iran. The latter bird is listed as near-threatened in *Threatened Birds of the World* (BI 2000). Although no status surveys have been made in the breeding range of the Basra reed warbler, the number of these birds seen in wintering habitat in Kenya has declined in recent years (BI 2000). A small portion of these marshes remains in adjoining Iran, but it cannot support a fraction of the wildlife that inhabited the Iraqi marshlands.

The worst oil spill in history took place in the Persian Gulf as Iraqi President Saddam Hussein, enraged at losing the war with Kuwait, opened and set afire that country's oil wells to spill 500 million gallons of oil into the delicate Gulf (Earle 1995). This represented 45 times the amount released by the *Exxon Valdez*. It added to the 250,000 barrels of oil released into the Persian Gulf every year for the past decade. The 1991 spill killed cormorants and other sea birds, sea turtles and dugongs. The fires belched toxic chemicals into the air and water in thick black clouds that darkened the sky at noon. Every plant and animal within many miles became coated with black soot. Marine scientist Sylvia Earle witnessed a bird in the midst of this hellish landscape as it swooped into a pool of oil, lured by a struggling dragonfly. "The bird barely moved, succumbing at once to shock, the slimy embrace gluing feathers, clogging nostrils, searing bright eyes, snuffing life" (Earle 1995). The 400-mile coastline of Kuwait, an expanse of marshes and mangroves, became covered in thick black oil, leaving only a few areas of untouched beaches protected by a causeway (Earle 1995). Tens of thousands of migrating shorebirds died in this oil along with a host of invertebrates and fish, and since much of the oil sank and attached itself to sand and mud, the oil killed for many years (Earle 1995). The most common coral in the Persian Gulf, staghorn, released eggs that were killed by the oil, and most of the adult coral in the region of the spill died or bleached (Earle 1995).

Geography-Draft

1600 to present					
	Number of Species Extinct				
Islands	**Birds**	**Mammals**	**Reptiles**	**Amphibians**	**Total**
Atlantic Islands					
Ascension I.	1				1
Canary Is.	1		1		2

Cape Verde Is.			1		1
Falkland Islands		1			1
Gull Island (Off NY, USA)		1			1
Iceland, Funt I. (Canada)	1				1
St. Helena	7				7
Subtotals	10	2	2		14
Caribbean					
Barbuda		2			2
Barbados		1			1
Bahamas	1				1
Caribbean region	2	1			3
Cayman Is.	1	1			2
Cuba	1	7			8
Guadeloupe	2		1		3
Hispaniola (Haiti & Domnican Republic)	1	15			16
Jamaica	4	2	2		8
Martinique	1	2	3		6
Navassa I.			1		1
Puerto Rico		6			6
St Croix (Virgin Is.)			1		1
St Lucia		2	1		3
St Vincent		1			1
Subtotals	13	40	9		62
Indian Ocean Islands					
Amsterdam Island	1				1
Christmas Island		3			3
Madagascar	2	1			3
Mascarene Is.	31	1	13		45
Seychelles	2		1		3
Subtotals	36	5	14		55
Mediterranean					
Sardinia		1			1
Subtotal		1			1
Pacific Islands					
Auckland I.	1				1
Bering I. region	1	1			2

Bonin Is.	3	1			4
Caroline Is.	3				3
Chatham Is.	5				5
Fiji Is.					1
Galapagos Is.		7	1		7
Guadalupe I.	2				2
Guam	1	1			2
Hawaiian Is.	21				21
Lord Howe & Norfolk Is.	6				6
Kangaroo I. (Australia)	1				1
Marquesas	1				1
New Caledonia	4				4
New Zealand	14	1	1		16
Okinawa		1			1
Pacific region	1				1
Palau		1			1
Philippines		3			3
Ryukyu Is.	1				1
Samoan Is.	1				1
Santa Cruz Is.		1			1
Society Is.	7				7
Solomon Is.	1				1
Tonga Is.	1				1
Vanuatu	1				1
Wake I.	1				1
Subtotal	77	17	2		96
Asia					
Indonesia	1				1
Subtotal	1				1
Island Totals	137	65	27		229
Mainlands					
Africa		5	1		6
Asia	2	1			3
Australia	2	22			24
Europe & Near East		2		1	3
Mexico & Central America	3	4		4	11

North America	3	1		1	5
South America	10				10
Mainland Totals	20	35	1	6	62

Source: Table of Extinct Species in the Appendix of this book. Sources of information are listed with the table.

Note: See the Appendix for the list of these species in chronological order, and the references that describe these animals and their extinctions, as well as those that include illustrations of the extinct species.

The following account chronicles some of the many extinctions and destructions of natural ecosystems that have taken place in North America over the past few hundred years. Great biological treasures have been stolen from future generations, and the processes by which they were lost are typical of those occurring elsewhere in the world. The sudden loss of the most abundant and prominent wildlife species of the continent created a profound shock in the public early in the century that set the stage for today's conservation and humane programs. This concern may turn the tide for species that could suffer the fate of the passenger pigeon (*Ectopistes migratorius*) and others, but unless public opinion is better translated into public policy regarding the land and wildlife, further losses will occur and the lessons that might have been learned will be ignored. A strong and pragmatic commitment to preserve what remains of the natural world on the continent, based on a realization that our fate is linked to nature's fate, is essential to prevent further extinctions.

Endangered Species Handbook

Vanishing Species:

Mauritius Blue Pigeon (Alectroenas nitidissima)
Last Record: 1826
© 2001/Peter Schouten

chapters AWI search

Vanishing Species

The Unraveling Tapestry

Now that prairies are plowed under and deserts are filled with subdivisions, the net effect of this recent massive habitat destruction and wildlife slaughter is being assessed. An incomplete tally in the United States, including Hawaii, totals at least 99 species of animals and 240 plants presumed extinct during the past 400 years (Stein *et al*. 2000). This high rate of extinctions reflects the losses of species and ecosystems described in Chapter 1, as well as those of Hawaii. The Nature Conservancy, which established Natural Heritage Programs in every state to monitor native species, has compiled this and related data to alert the public of the urgent need to preserve the country's natural heritage (Stein and Flack 1997; Stein *et al*. 2000). Its examination of the status of 20,439 US plants and animals found 7,817 species (38 percent) to be either vulnerable, imperiled or critically imperiled (Stein *et al*. 2000). These conclusions were published in a book co-authored with the Association for Biodiversity Information, entitled *Precious Heritage: The Status of Biodiversity in the United States* (Stein *et al.* 2000). This book also illustrates many of these beautiful plants and animals and threatened ecosystems. It found more species in danger than the *2000 IUCN Red List* due to slightly different categories, such as imperiled and critically imperiled, rather than critical and endangered, used in IUCN lists. The latter organization also defines threatened species in terms of the rate of their decline, rather than their actual status.

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Precious Heritage found endemic species, defined as those restricted to the bounds of the United States, and breeding endemics, or those breeding only in the United States, were even more threatened than those with wide distributions. Of the 875 endemic vertebrates in the lower 48 states, almost half (47 percent) are of conservation concern, compared to only 24 percent of all US vertebrate species (Stein *et al*. 2000). 90 percent of Hawaii™s endemics are imperiled in this study. Freshwater species such as mussels, crayfish, beetles and dragonflies are also in steep decline (Stein *et al.* 2000). More than 5,090 plants (33 percent of all native species) are threatened.

Other studies are examining natural ecosystems in the country. The National Biological Service of the US Department of the Interior reported in 1995 that during the 20th century alone, half the natural ecosystems of the lower 48 states became degraded to the point of endangerment (Stevens 1995). More than 1,700 biologists participated in this study, part of a massive biological survey of America's plants and animals (Stevens 1995). Along with the loss of the tall grass prairies and oak savannahs, more than 60 million acres of longleaf pine forests in the Southeast have been cut, and much of this land has been planted with tree farms, creating biologically sterile regions. Northeastern old-growth hardwood forests, likewise, are critically endangered, and survive only in scattered remnants (Stevens 1995). Grasslands in Long Island, the Northeast and California are threatened ecosystems, as are coastal prairies in Louisiana and sedge meadows in Wisconsin. Streams in the Mississippi plain have been greatly damaged as well (Stevens 1995). Fifty-eight natural communities have declined by 85 to 98 percent, and 38 others have declined by 70 to 84 percent (Stevens 1995). The National Biological Service has identified 126 endangered species through this study. Each imperiled ecosystem is home to many threatened species, a reflection of their loss of habitat. This study underlined the importance of preserving large areas instead of small tracts of land, although the latter may be the only way to protect some highly endangered species, such as plants that have become greatly restricted in range.

A 1997 study by the joint United States and Canadian branches of the World Wildlife Fund (WWF), "A Conservation Assessment of the Terrestrial Ecoregions of North America," appraised the ecoregions of the continent including Hawaii (Luoma 1997). Ecoregions are areas defined by major habitat types and, unlike ecosystems, are confined to particular areas. Eastern old-growth forests, for example, are ecosystems scattered over a great area amongst other ecosystems, while southeastern conifer forests constitute an ecoregion. This study found 13 of the continent's 116 ecoregions to be imperiled "hot spots," harboring enormous biological diversity (Luoma 1997). These include Florida's pine scrub, the conifer forests of the Southeast, Appalachia's mixed mesophytic forests, the

tallgrass prairie and California coastal sage and chaparral (Luoma 1997). These findings were echoed in the world survey of threatened areas with great biological diversity, *Hotspots*, sponsored by Conservation International (Mittermeier *et al*. 1999). The latter book is illustrated with spectacular color photographs of many disappearing landscapes and species of endangered hotspots, such as the California coastal region.

An inventory of rare, endangered and extinct North American plants and animals, being compiled by the National Biological Service, has verified that the impoverishment of America's natural ecosystems has affected not just isolated species, but entire communities of species. It predicts a steady increase in the number of threatened species because of continued destruction of natural habitats. Habitat loss is the greatest threat to US wildlife and plants, but trade, persecution and pollution play roles as well. Agriculture was ranked as the primary threat to native US species by The Nature Conservancy study, threatening about 45 percent of plants and animals, while development of land followed, threatening about 34 percent; water projects were the next major threat, and livestock grazing, pollutants, road building, logging and mining had important, but lesser, effects on species and ecosystems (Stein *et al*. 2000).

Threatened species tend to be located in certain "hot spots" in the United States. The one with the largest number of species is Hawaii, with 5,000 populations of species considered imperiled by The Nature Conservancy (Stein *et al*. 2000). In the continental United States, a preponderance of threatened species occurs in the Florida Panhandle, central Florida and the Florida Keys, the Appalachian Mountains, the Cumberlands and Southern Ridge, Cape Cod and Martha's Vineyard, southern California, the Pacific Northwest and southeastern Alaska, as mapped in *Precious Heritage. The Status of Biodiversity in the United States* (Stein *et al*. 2000; page 166). The Cumberlands and Southern Ridge and Valley of northern Alabama and southeastern Tennessee have the country's largest number of imperiled species--186--mainly as a result of the mussels, crayfish and freshwater snails of this region. The Central Appalachian Forest to the northeast has 154 threatened species, with a high percentage of aquatic species as well, including many rare salamanders and woodland plants. The Great Basin Desert of Utah and neighboring states is another species-rich area, with 113 threatened species, while the California South Coast sagebrush ecosystem has 138 threatened species found nowhere else on Earth (Stein *et al*. 2000). (See Grasslands, Shrublands and Deserts chapter).

The list of US species in danger of extinction grows longer each year, with a dramatic rise in the number of imperiled invertebrates in the 20th century. Fully 68 percent of freshwater mussels, more than 100 species, are threatened, making them the most endangered group of native animals. Fifty percent of native crayfish are threatened, according to the Nature Conservancy (Clancy 1997). The majority of surviving species are highly endangered from alteration of their clear, fast-flowing rivers and streams by federally sponsored dams, channeling and diking that have turned most waterways in the Southeast into muddy ditches and artificial lakes. Pollution and introduction of non-indigenous species of mollusks and crustaceans competing for food have also played roles in the decline of some of these mussels and crayfish. The Hawaiian Islands are home to a variety of colorful and endemic tree snails. Introduction of exotic snail species and habitat destruction have already extinguished many of these, and endangered others.

Many species of butterflies, which are important pollinators, are in decline. The Xerces Blue (*Glaucopsyche xerces*), a beautiful butterfly native to California, became extinct in the 1940s (Stein *et al*. 2000). Eight moth species and two other mainland butterflies are possibly extinct, as are 50 bee species native to Hawaii (Stein *et al*. 2000). Eight mainland butterfly species are critically endangered, and 109 are threatened, according to The Nature Conservancy (Stein *et al*. 2000). Dragonflies and damselflies, which predate the dinosaurs, have also lost ground. Two Hawaiian species are possibly extinct, and 79 more are considered imperiled (Stein *et al*. 2000).

Seventeen species of freshwater fish are extinct or possibly extinct, and the United States leads the world in the number of threatened freshwater fish: The Nature Conservancy lists 283 species (Stein *et al*. 2000). Habitat loss in the form of dams, river diversion and channeling, as well as pollution, has played major roles endangering these fish. Logging has destroyed many clear rivers and streams where salmon and trout breed. The majority of rivers and bodies of water are still polluted despite the Clean Water Act, and contaminants have caused malformations and high mortalities in fish populations. Introductions of non-indigenous fish for sport fishing have imperiled a large number

of species. Brown Trout from Europe and Rainbow Trout placed in areas where they are not native have severely threatened native trout, such as the Cutthroat Trout of western lakes and rivers. In many cases, multiple factors combine to push native fish toward extinction.

The United States is second only to Australia in the number of threatened reptiles and amphibians. The Nature Conservancy lists 51 imperiled reptiles and 82 imperiled amphibian species (Stein. 2000). This amounts to an estimated 40 percent of US amphibians, and 18 percent of native reptiles--extremely high rates. Amphibians are declining worldwide from various causes including habitat loss, pollution, disease, pesticides and ultraviolet radiation from thinning of the Earth's ozone layer.

The total of 71 US bird species that BirdLife International's research placed in various categories of threat includes 33 species from the Hawaiian Islands (BI 2000). The Nature Conservancy found an even greater number through their intensive Natural Heritage Program research: 83 species of birds at risk in the United States, or about 11 percent of all native species (Stein *et al*. 2000). This is a smaller percentage than for reptiles and amphibians but, when analyzed by region, a large percentage of Hawaii's birds are threatened. A steady increase in the number of threatened birds has occurred in this century. The major causes threatening US mainland and seabirds are destruction of habitat, pesticides and pollution. In the Hawaiian Islands, introduced animals, disease and destruction of forests and wetlands are the major threats to endemic birds, as well as to plant life and invertebrate fauna.

The Nature Conservancy considers 65 species of US mammals, or about 16 percent of all native mammals, to be threatened (Stein *et al*. 2000). The loss of habitat from development, logging, livestock grazing, mining and other forms of destruction is the foremost threat to mammals. Added to this, pollution affects many aquatic mammals, and predator and rodent control programs to benefit livestock and agricultural interests affect foxes, wolves, and prairie dogs. A growing number of bats have been added to the list of threatened US mammals, an indication of a loss of habitat, as a result of caves being disturbed or vandalized, loss of large roosting trees to logging, pesticide use, and persecution by those not aware of bats™ ecological importance and who have exaggerated ideas of their supposed threats to humans.

Although lists of native North American threatened plants are far from complete, they reflect the rate at which ecosystems have become imperiled. The Nature Conservancy found 6,460 United States vascular plants to be imperiled (Stein *et al*. 2000). Of these, a very large number--1,385--are Critically Imperiled, 1,341 Imperiled and 3,338 species Vulnerable. Hawaii is a center for threatened plants. The *1997 IUCN Red List of Threatened Plants* found a somewhat smaller number of threatened US plants; 4,488 species, or 29 percent of native plants. Still, the United States had the highest number of endangered plants of any country in the world (Walter and Gillett 1998). In terms of the percent of native plants that are threatened, only St. Helena, Mauritius, and the Seychelles had higher rates (Walter and Gillett 1998) Few countries of the world have legislation similar to the US Endangered Species Act, which has helped hundreds of endangered plants.

Many US plants are adapted to specific types of soil or microclimates, and human disturbances can threaten them. Prairie plants are among the most threatened. California's grasslands have been reduced by more than 90 percent, leaving many endangered plants; it has many endemic species in its southern chaparral and shrubland, which are being bulldozed to make way for new housing developments. The state's mild climate and varied landscape have given rise to great diversity, which is extremely threatened. Of 25 presumed and 21 possibly extinct species in the state, about half, or 24, are plants (Stein and Flack 1997). Although endemic plants are not as numerous on the mainland as in some island habitats, North America is home to a great many unique and beautiful plants, which are finally beginning to receive the conservation attention they deserve.

Research is uncovering potential economic value in some native plants. One threatened US plant, the Scrub Mint (*Dicerandra frutescens*), yields a natural insecticide in its oil that repels a wide variety of insects, from ants to cockroaches (Aylsworth 1998). This white-flowered plant is presently restricted to a few hundred acres in central Florida, and it only came under scrutiny in the 1990s, when a Cornell biologist, Dr. Thomas Eisner, discovered its

potential as a natural insecticide (Aylsworth 1990). This mint may be protected from extinction in time, thanks in large part to Eisner's research.

In spite of some sizeable natural areas in the United States preserved by the Wilderness Act and as federal or state land holdings, the country has become increasingly urbanized and cultivated for agriculture. Americans have gradually altered the landscape so that much of it, especially in the East, now resembles Western Europe's heavily populated countries where wilderness has been all but eliminated.

Recent ecological research on the effects of suburban sprawl on the environment have shown it to crowd out as many species as more densely populated areas (Revkin 1997). Diversity of species declines in these areas as green lawns, manicured gardens and asphalt cover the land and pollute the ground water with pesticides, fertilizers and herbicides and kill off beneficial insects and other animals. Developers drain beaver ponds and wetlands and turn streams and rivers into concrete-lined ditches. With each acre lost, species decline. The brilliantly colored warblers and songbirds of eastern forests, for example, have been severely affected by fragmentation of both their breeding and wintering habitats. For the majority of such declining species, endangered listing comes only when they have been reduced to a small fraction of their original populations. The species that are listed by the IUCN or The Nature Conservancy in various categories of threat have reached a point where their very survival is at risk. In some cases, species, which were once described as naturally rare, are very restricted in distribution, especially plants and fish inhabiting desert springs or mollusks found only in a particular river system. For the majority of threatened US wildlife, however, their status a few hundred years ago would have been described as secure. It is all the more indicative of a crisis situation regarding American biodiversity that so many species, and such large percentages of their classes or types, are now headed toward extinction.

Should all US species currently threatened become extinct, a biological tragedy will take place. Preventing such a catastrophe has not yet captured the public™s attention or involved a zealous effort on the part of the US government. Important work on biodiversity studies is being done by various federal agencies, but the major burden of activism regarding preservation of endangered species and the environment has fallen to private conservation organizations.

The WWF report entitled "A Conservation Assessment of the Terrestrial Ecoregions of North America," accuses the US government of "doing a worse job of protecting its biological resources than many poorer countries with few resources for biodiversity conservation" (Luoma 1997). It concludes that the wealthiest country in the world places the preservation of its natural resources among its lowest priorities.

Without detailed information on the biodiversity of this country, it will be impossible to protect it, yet funds are inadequate to carry out a comprehensive assessment. Many opponents of the biodiversity studies in Congress have expressed fear that they would be used to expand the list of species on the Endangered Species Act and obstruct development programs. They succeeded in blocking formation of the National Biological Service, which Clinton Administration Secretary of the Interior Bruce Babbitt had to create administratively. The constant deterioration of the land through development, pollution and introduction of exotic species makes these studies all the more timely. This is a critical time of rapid environmental destruction and a turning point for many species which, without urgent protective action, will follow the deadly trails of the Passenger Pigeon, Carolina Parakeet, Sea Mink and hundreds of other lost plants and animals.

The US Endangered Species Act is one of the strongest and most effective laws in the world and has been a model for similar legislation globally. Many countries, including Canada, still lack national endangered species laws. Although private organizations acquire habitat and carry out many important programs, the legal protection the Endangered Species Act provides is key to the protection of many endangered species and their habitats. It has been responsible for saving a number of species, including the California Condor (*Gyps californianus*), Black-footed Ferret (*Mustela nigripes*), Whooping Crane (*Grus americana*) and numerous other animals and plants. The law has helped fund research, captive breeding, protection in the wild, reintroduction programs, land acquisition and law enforcement protection.

The law must be reauthorized regularly by Congress, however, and at these times, efforts to weaken or even fail to authorize it threaten its effectiveness and very existence. The strong support the law has received from the US public is not always evident in the halls of Congress, where commercial interests and lobbyists have had considerable influence. To date, the law has survived, although it has been amended and weakened somewhat since its enactment. The blocking of listings on the Endangered Species Act by its opponents has become the major means of thwarting the Act. Lawsuits have been filed by both opponents and proponents of the law demanding either delisting of species or listing and critical habitat designation. A virtual impasse has resulted in a moratorium on listing new species which the Department of the Interior declared in 2000.

Many listings have been thwarted by commercial interests. In a recent case, a proposal to list the Lynx (*Lynx canadensis*) on the Endangered Species Act was not acted upon by the Fish and Wildlife Service without a lengthy struggle. This species has greatly declined from its once large range in the lower 48 states. Heavy trapping for its valuable fur and logging of its habitat of mature pine forests have reduced its populations to fewer than 1,000 animals. The majority of Lynx remain in Montana, Idaho, Washington and Maine. Although the Fish and Wildlife Service's (FWS) own biologists found this population to be endangered, they were overruled by headquarters whose bureaucrats decided to refuse to list the species on the Endangered Species Act (Cushman 1998). Petitions by conservationists urging Endangered Species Act listing for the Lynx were ignored, and only when a lawsuit was filed against FWS did the tide begin to turn in this endangered cat's favor. Conservationists won the suit in 1997, but the FWS, in an unprecedented action, declined to list the Lynx, stating that other species had higher priority for listing. Loggers and commercial timber companies oppose listing the Lynx, fearing that areas would be set aside as critical habitat where no tree cutting would be allowed, and many conservationists believed that FWS had succumbed to these pressures. Finally, in February 1998, the Service and several conservation groups reached an agreement to list the Lynx on the Endangered Species Act to take effect in 1999 (Cushman 1998). President Clinton declared a moratorium on new road building in national forests lands in 2000, which will greatly aid the Lynx and other threatened species of these forests, such as the Wolverine and Marten.

The Public Employees for Environmental Responsibility (PEER) issued a report in December 1997 accusing the FWS of failing to protect more than 300 species awaiting listing. Only listings of plants have increased in recent years, leaving a growing number of animals in need of federal listing (Stein *et al*. 2000). The Nature Conservancy's biological surveys have uncovered a far greater number of endangered and threatened species in the United States than are listed by the Endangered Species Act, especially plants.

On the positive side, an increase in the number of endangered species added to the Endangered Species Act has been seen in recent years. The Endangered Species Act, in spite of shortcomings, is vital to the preservation of endangered species in the United States, and it is in grave danger of being weakened so much that it will become ineffective. Various proposals in 2001 made by the Bush Administration would make it nearly impossible for citizens to sue the government to force listing of endangered species (Jehl 2001). The majority of species on the Endangered Species Act were listed as a result of citizen suits (Jehl 2001, Gorov 2001). The Fish and Wildlife Service claims to be unable to perform its duties because of the large number of legal challenges. The law has not been reauthorized since 1991, and proposed changes might leave actions regarding endangered species to the discretion of the Department of the Interior, rather than basing them on biological status. Under the new plan, citizens could petition for listings, but the government would not have to respond promptly, nor would it have to act on designating critical habitats for endangered and threatened species (Gorov 2001). So little money--$6.4 million--is budgeted for listing that a stalemate is inevitable. Other proposals by the Bush Administration would cut overall spending on endangered species programs by $11 million, leaving the Office of Endangered Species without the means to accomplish its purpose (Gorov 2001).

A number of private organizations have aided in preserving endangered and endemic plants not listed on the Endangered Species Act. The Nature Conservancy and its state Natural Heritage Programs have purchased or arranged purchase of hundreds of thousands of acres of land for threatened plants. Arboretums and botanical gardens,

such as the Missouri and the New York Botanical Gardens, also are active in this regard. Lady Bird Johnson helped found the extremely effective organization, the National Wildflower Research Center, which aids in the conservation of wildflowers. In the northeast, the New England Plant Conservation Program has spent six years collecting seeds from some 500 rare plants for a seed bank. The New England Wild Flower Society has been instrumental in this program, and many sanctuaries throughout the region are preserving threatened plants.

The actions of individual states under their state endangered species laws and Natural Heritage Programs have also been crucial to the survival of many species that are threatened within a state or region, but might not qualify for federal listing. Programs to reintroduce Bald Eagles (*Haliaeetus leucocephalus*), Peregrine Falcons (*Falco peregrinus*), threatened fish and River Otters (*Lutra canadensis*) have brought back these species in many areas where they had been eliminated by pesticides, over-trapping, pollution or water projects. Many programs have involved cooperation between state and federal endangered species officials.

Habitat Conservation Plans (HCPs) are agreements worked out between landowners and the Fish and Wildlife Service for listed endangered species under a 1982 amendment to the Endangered Species Act. In essence, they are the result of deals made among developers, state and county officials, Fish and Wildlife Service representatives and local citizen groups on large tracts of land, in which portions of endangered species' habitats are protected, while development is allowed on the rest. HCPs are a permanent contract that cannot be amended, even if biological information is revealed showing that they were in error. These HCPs have been the center of much controversy, considered by some conservationists to compromise the principles of the Endangered Species Act, and by others to be an excellent means of protecting species. HCPs are not presently published in the *Federal Register* prior to signing by the Secretary of the Interior, which would subject them to public comment.

In 1997, a team of 119 scientists, financed by the National Science Foundation and the American Institute for Biological Sciences, carried out careful appraisals of signed HCPs and reported on their conclusions. They found that crucial scientific knowledge was lacking about many of the species involved in these agreements (Yoon 1997). They also found misuse of scientific methods and biological data which will end in harming, rather than helping, many species (Yoon 1997). Dr. Peter Kareiva, a University of Washington ecologist who organized the study, concluded that many HCPs should not have been written, and only about half correctly employed science (Yoon 1997). Of 206 HCPs examined in total, 44 of them in detail, one-third lacked information as basic as life span of species, and the vast majority did not include data on rates of population rise and decline and habitat changes (Yoon 1997). The most glaring problem seen by the scientists was the failure of HCPs to correctly assess the impact of losses to species' populations, mainly as a result of untested methods of appraising impacts. One plan proposed to protect Utah Prairie Dogs (*Cynomys parvidens*) by moving animals to a new location using a method already known to result in the deaths of 97 percent of the relocated animals within three months (Yoon 1997). An HCP for the Desert Tortoise (*Gopherus agassizi*) in Nevada allowed the killing of hundreds of these threatened reptiles by bulldozing their burrows and habitat, while protecting only minimal amounts of habitat.

A major problem faced by those trying to save endangered species is the fact that the vast majority live on privately owned land, and arrangements must be made with owners to insure the survival of these species. Many people believe that protecting these species involves major restrictions on the use of their land and, therefore do not want to enter into Habitat Conservation Plans. Ideally, however, protecting a threatened butterfly or plant on a private ranch, for example, would only involve identifying the habitat, the host plants for the butterfly, and preventing destruction through excavations or other major alteration of the land. In many cases, cattle grazing is compatible with protection of rare species, since the land is not plowed, which can destroy plant life. Ranchers in southern Arizona have cooperated in protecting the land through preventing overgrazing and maintaining riverbank vegetation and springs for rare frogs and birds. For many endangered species, conservation easements are an excellent solution for their protection. These easements involve the payment of funds to the landowner by private organizations, or local, state or federal governments to let the land remain undeveloped and help enhance it as wildlife habitat. This is an especially good solution for farmers who are afraid of losing their land after years of crop failure or low market prices. Innovation has marked many arrangements now being made to protect endangered and endemic species.

The US public as a whole supports the protection of endangered species, which helps explain the Endangered Species Act's survival under strong opposition. Polls conducted in November 1994 by Peter D. Hart Research Associates found that 57 percent of the public wanted to maintain the Endangered Species Act in its present form, and only 32 percent wanted to relax requirements. A September 1995 CNN poll asked which was more important, saving endangered species or saving jobs: 48 percent replied endangered species, and 40 percent, jobs. A Gallup poll carried out for CNN in April 2001 found that support remained strong. It asked Americans whether they supported environmental and wildlife protection even if it meant higher prices or more jobs, and again, a majority supported conservation. They were also asked to rank environmental protection in terms of its importance as an issue, and most placed it near the bottom of the list. When asked whether it would be an important issue in 25 years, however, the majority said it would be among the most important issues. This reflects a failure to understand the ongoing wave of extinctions that is eliminating many of the Earth's most fragile plants and animals and its possible effect on humans.

Thus, education is extremely important, especially its role in relating American lifestyles and waste of resources to the extinction and endangerment of species. A 2001 film, "Natural Connections" (Howard Rosen Productions, shown on PBS), addresses this issue as well as the gradual diminution of biodiversity. The overconsumption that Americans take for granted impoverishes nature in the US as well as in other countries that export their tropical hardwoods; cut flowers; leather from cows grazed in former rainforests; non-organic, sun-grown coffee; minerals; and handcrafts from scarce materials to this country. Other products are manufactured as a result of polluting the environment and, like coated paper cups or pulp magazines, are used once and thrown away. To maintain such a throw-away lifestyle, millions of trees are cut each year in the United States and elsewhere, disrupting ecosystems and threatening wildlife. Pollution is created from mines that poison rivers, and manufacturing and power plants that spew dioxin and greenhouse gases into the air. The urgency that gave rise to legislation early in the 20th century that protected native birds and other wildlife from overexploitation for commercial purposes was enacted after the extinctions of the Passenger Pigeon and Carolina Parakeet, and near-extinction of the American Bison (*Bison bison*) and other animals from 19th century slaughters. It would be tragic if a similar wildlife or environmental catastrophe were needed to spur strong action to preserve the world's genetic and biological heritage.

Threatened Species of the World

The *2000 IUCN Red List* found 3,507 vertebrates and 1,928 invertebrates in high degrees of threat worldwide (Hilton-Taylor 2000). Plants classified as Critical, Endangered or Vulnerable totaled 5,611 species. These are minimum figures because only birds and mammals have been thoroughly examined for status. When assessments are carried out on the remaining species, the list will doubtless grow far longer.

Many of the most magnificent, graceful, beautiful and zoologically curious animals on Earth are threatened with extinction. A growing number of these, such as sea turtles, sharks and crocodiles, have survived virtually unchanged for hundreds of millions of years, and if not for the human activities that are pushing them toward extinction, they would likely survive millions more.

Almost all the graceful cranes, on Earth since the Miocene Epoch, are endangered from loss of habitat and hunting. The entire family of prehistoric-looking rhinoceros is teetering on the brink of extinction. New Zealand's extraordinary and primitive kiwis and ancient tuatara lizards, which have survived since the dinosaur epochs, may be lost in the next few decades. Eleven of the 16 species of penguins are now threatened, nine in higher categories (BI 2000). Seabirds of many types, including the majority of albatross, are now listed.

The most surprising finding was the high number of mammals listed: 2,046 species, of which 1,130 species were in higher categories of threat (Critical, Endangered and Vulnerable). Thus, of the approximately 4,000 species of mammals, 28 percent are highly threatened, and more than half are in some degree of threat. They are the most imperiled class of animals. Twelve percent of birds, or one in eight species, are listed in higher categories of threat (1,186 species), and an additional 809 species are in lesser categories (Near-Threatened, Conservation Dependent, or Data Deficient), totaling 1,995 species or about 18 percent of the world's birds (BI 2000). Reptiles are a group less well assessed, but 750 species are at risk in all categories, according to the *2000 IUCN Red List*. Amphibians, which number about 4,550 species worldwide, have a minimum of 226 threatened species, and a large additional number that have not been thoroughly assessed. Likewise, very few marine fish are listed by the IUCN because so little is known of their status. Some progress is being made in assessing marine fish, especially coral reef fish and sharks and rays. By 2003, a complete assessment of the shark family is planned by IUCN (Hilton-Taylor 2000). Approximately 1,183 fish are listed in the most recent *IUCN Red List* in various categories of threat. The majority of these are freshwater species, which represent 6 percent of all known fish.

The rate at which animals and plants are declining has reached such proportions that even familiar species considered common with stable populations only a decade ago are now threatened. The African Lion (*Panthera leo*) and many African antelope, Giraffes and wildebeests are in serious decline, or exist only in parks and reserves, categorized as Conservation Dependent.

Animals listed as Near-Threatened or Data Deficient totaled 3,324 species, of which 2,364 species are vertebrates in the *2000 IUCN Red List*. The grand total of 8,759 vertebrates in all categories comprises 20 percent of all mammals, birds, reptiles, amphibians and fish on Earth. In the early 1980s, only 1,000 vertebrates were listed by the IUCN. This means that in just 20 years, this total has risen by almost 900 percent.

Plants have been assessed in several reports. The *1997 IUCN Red List of Threatened Plants* (Walter and Gillett 1998) was supplemented--and many species reassessed--by the *2000 IUCN Red List* (Hilton-Taylor 2000). Plants from Cameroon, the Galapagos, Mauritius and South Africa were added to the 2000 list. A total of 6,932 plants were listed in all categories, 5,611 in higher categories of threat. In spite of these major undertakings, only conifers were thoroughly assessed. The 1997 study, using one type of definition based on status alone, found 30 percent of all conifers to be either Endangered or Vulnerable; the 2000 reappraisal, using new criteria, determined that 16 percent were threatened (Hilton-Taylor 2000). When far more species of plants are assessed, The Nature Conservancy study of US plants (Stein *et al*. 2000), which found one-third of plants to be threatened, may be indicative of a great decline in the world's plants.

As in the case of animals, many of the Earth's oldest species of plants are at high risk of extinction. Trees that predated the dinosaurs and survive in pockets in Chile, New Zealand, New Caledonia, Australia, New Guinea and parts of Southeast Asia are being destroyed, with little knowledge of their extreme botanical importance. Many of these are among the largest trees in the world, rivaling the Redwoods in height and the Sequoias in girth (see Forests chapter). Others, such as the monkey puzzle tree family, are extremely bizarre in appearance, and may contain important compounds for medicines. Beautiful primitive flowers, the protea, are also greatly threatened, with many species growing in South Africa. Tree ferns, palms and hundreds of orchid species are also highly threatened. The island of Mauritius has a large number of threatened plants, many of which are quite unique.

Many zoologists and conservationists are now resigned to the rising level of extinctions and believe that, within a century, 80 percent of all species living today will be extinct. Such predictions may be overly pessimistic, but unless the public is made more aware of the precarious status of a growing number of plants and animals and demands strong action, the prognosis may be fulfilled.

What is Threatening Species?

Human activities are at the root of virtually all extinction threats. Destruction of fragile habitats, wetlands, coral reefs, tropical and temperate forests, rivers and grasslands has accelerated in recent years due to human population increases and commercial exploitation of forests, ocean fish and other wildlife, as well as the introduction of non-native species, either intentionally or accidentally. The massive pollution and chemical contamination of air, water and soil--and even the atmosphere that surrounds the Earth--are altering the climate and bringing about unforeseen declines in wildlife and plants.

Human Tragedy and the Looting of Virunga's Treasures

What is Threatening Species? Human Population Growth

Burgeoning human populations provide the major impetus for destruction of the last havens for rare species. In 1650, when Dodos were still common on the island of Mauritius, the world's human population totaled about 500 million, half of India's present population. Two hundred years later, the number had doubled to 1 billion. In 1900, the world's population totaled 1.6 billion. Since then, it has taken shorter periods for the world's population to double, and at present it doubles approximately every 37 years. In 2000, 6 billion people lived on Earth, a number expected to rise to

between 8.5 and 9.4 billion by 2050. While population growth has leveled off in parts of Europe, Russia and Australia, it continues to rise in the United States, mainly as a result of immigration. The highest rates of growth, 3 percent or more, occur in Africa, Asia and Latin America, where environmental deterioration has been severe. The similarity between the astronomic rise in human population and the extinction rate of animals and plants is not accidental.

Settlers in increasing numbers are entering tropical forests, grasslands and other wild areas teeming with wildlife, and clearing them for grazing livestock and planting crops. Loggers in the Brazilian and Central African rainforest wildernesses are building roads to transport entire forests of trees, some thousands of years old, to be sold in markets in North America, Europe and Asia. The roads open up the forests to settlers and hunters, endangering countless species of animals. Commercial exploitation of forests has increased rapidly since the 1980s, with logs turned into pulp for paper, expensive lawn furniture, paneling, shipping cartons, and even concrete molds that are used once by builders and thrown away. Rivers are becoming increasingly polluted from human waste that goes untreated in many parts of the world, and billions of people scratch out a living by subsistence farming, cutting trees for fuel and grazing livestock.

These poverty-stricken people have caused the limits of the Sahara and Sahel in Africa to expand by depleting wildlife and trees, and have razed forests in India, China, Indonesia, Thailand, Ecuador, Central America, Mexico and West Africa. Still, many go hungry because they have far outstripped what the land could supply sustainably. For the wealthier nations, an appetite for material goods and demand for a high standard of living have encouraged a market for precious resources, such as tropical lumber and wildlife products, that has expanded in recent years with the World Trade Organization (WTO) globalized economy. In order to repay loans granted to them by international funds, many poor nations strip their forests and grow exportable crops on the land. In the United States, urban sprawl and overexploitation of forests and other resources have threatened a host of animals and plants. Water is diverted for these new towns, endangering native fish and forests. In Arizona, the Sonoran Desert, a botanical world treasure, is now being destroyed by the expanding cities of Phoenix and Tucson.

The needs of the growing numbers of people worldwide have spawned many ill-conceived and environmentally destructive projects. Indonesia and Brazil opened up the most biologically rich forests on Earth to farming by people living in overpopulated cities. The soil is poor in tropical forests, and they must keep clearing land to find new areas for crops, gradually destroying vast areas once teeming with wildlife. China has moved people into western grasslands, where they have eliminated wildlife and caused massive erosion and desertification with agriculture and overgrazing of livestock. Dust storms from this region have been circling the globe in recent years. China has also commissioned the world's largest dam, Three Gorges--on the Yangtze River--in an attempt to control floods and generate electricity. In the process, a very rare freshwater dolphin, a sturgeon, and hundreds of rare plants will become extinct, and the dam's lake will fill with untreated sewage. The problem of overpopulation has not been well understood or coped with in the majority of countries where populations are now outstripping food supply.

In most parts of the world, however, people have deforested the habitats and killed prey species of wide-ranging wildlife that have nowhere else to go. Asian Elephants (*Elaphus maximus*) and Tigers (*Panthera tigris*), for example, have been deprived of habitat and food and crowded into areas too small for their requirements. When they rampaged into people's gardens or killed livestock, they were killed and their body parts sold for high prices. Both species are now endangered, their populations fragmented and in steep decline. This is a pattern that has been seen with large animals, especially predators, throughout the world. Animals or plants with low populations as a result of restricted habitat size or specialized requirements for survival have been pushed to the brink of extinction as humans moved into their habitats.

Only a few countries have national policies to encourage stable populations. In some countries with populations that far exceed the ability of the land to adequately sustain them, wars have broken out, providing an apocalyptic vision of a violent future for the Earth should present trends continue. A scientific study, *Environmental Change and Violent Conflict* (Homer-Dixon *et al*. 1993), predicted that as human populations increase and resources decrease, wars will

occur with ever greater frequency. Population Action International, a Washington, DC-based organization, calculated in 1997 that although human population growth has slowed somewhat, water resources remain under serious threat. This organization's report warns that by 2050, people in the Middle East and parts of Africa, where populations continue to grow at high rates, will be engaged in bitter, violent conflicts over water. The story of the Rwandan war, described later in this chapter, reflects this cause and effect. Overpopulation causes human suffering, permanent damage to the land from overuse, and the destruction of the very species that might prove life-saving. A few countries, such as Singapore, launched education programs decades ago, urging people to have smaller families for a better quality of life. The rate of population increase in this tiny country is now less than 1 percent, and literacy is 91 percent.

Medical advances preventing disease and early mortality in people around the world, combined with growth in agricultural output, have played a major role in the nearly four-fold rise in human population since 1900. The World Health Organization (WHO) has scoured the planet eradicating disease but is not required to educate people about birth control methods. This has decreased natural mortality and fueled population booms. The majority of international aid projects lack overview, coordination with one another and long-term planning. Supplying high-yield grain and financing irrigation projects to poor nations, without providing birth control education, results in a doubling of populations within a generation, which negates any rise in the standard of living and education levels. By encouraging livestock and agriculture in dryland areas, with little knowledge about the natural environment or its capacity to support large numbers of people, wildlife and plants are displaced or killed, and in years of drought, crop failures result, causing starvation. The human suffering brings international aid with emergency food, and instead of relocating people to other areas, these programs encourage replanting and a repetition of the misfortune.

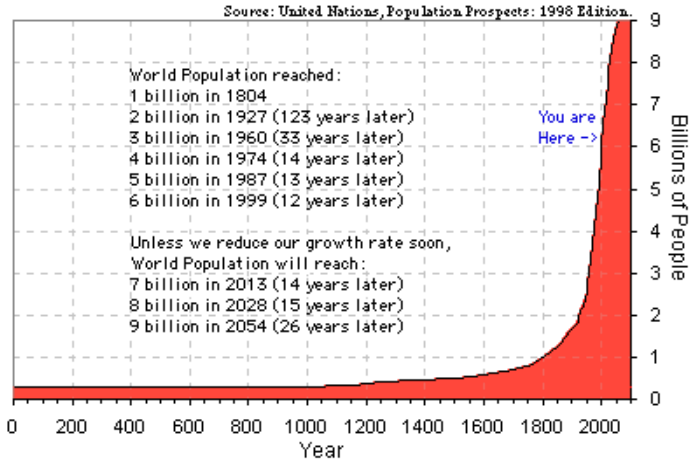
Ethiopia and Somalia are examples of such policy failures. These countries were covered in a mosaic of grasslands and forests teeming with endemic wildlife early in the 20th century. An influx of large numbers of people and livestock, encouraged by aid programs, denuded this region to arid desert. The vast numbers of wildlife have largely disappeared or become endangered as the extensive grasslands, rivers, lakes and highland forests disappeared because of overgrazing, farming in areas too dry to produce crops and deforestation for firewood (see Grasslands, Shrublands and Deserts chapter). With low human and livestock population densities, these areas could have remained ecological treasures.

The Population Institute of Washington, DC, warns that although some countries have shown declining rates of population increase, especially those in Western Europe and North America, this will not result in an overall decline in world population because of greater human longevity, continued high birth rates in at least 74 countries and a high survival rate (Holmes 1997).

The top 10 countries in terms of overall numbers of people have 59 percent of the world's population. More than 30 percent of all births in 1997 took place in India, a country expected to overtake China as the world's most populous nation by 2050 (Holmes 1997). A 1997 World Bank report, "The World Food Situation: Recent Developments, Emerging Issues and Long-Term Prospects," concluded that food stocks are not keeping up with need (Crossette 1997b). Demand for meat is increasing, placing further stresses on natural systems since livestock consume enormous amounts of grasses and grain, cause damage to vegetation and often pollute water systems; grain production is reaching the limit of potential yields, especially in Asia (Crossette 1997b).

The most densely populated country in the world, Bangladesh, with 127.5 million people, has about half the population of the United States in an area the size of Wisconsin. It has a density of almost 3,000 people per square mile, and a population growth rate of 2 percent a year. Ninety percent of the people in Bangladesh's countryside are illiterate and malnourished in spite of decades of international aid projects. Bangladesh is now totally dependent on foreign aid for minimum nutrition, and the land is being worked to maximize yields, using large quantities of fertilizer, irrigation and pesticides. The once vast mangrove forests that serve as fish and shellfish nurseries, and habitat for Tigers and other endangered species, are being destroyed piecemeal, cut for firewood (Worker 1996).

Funds to encourage birth control around the world have been deleted from US budgets by those opposed to abortion, thus thwarting all types of programs of education, birth control methods and related issues. Most organizations working to lower birth rates around the world use almost no funds for abortion, yet they find their funds cut for all family planning programs. This obstructionism has been a major setback to those working to stabilize the world's populations. The United Nations Population Fund has continued to carry out family planning programs, but with inadequate funds.



What is Threatening Species? Habitats Under Threat

Habitat destruction is the foremost threat to wildlife. In broad terms, more than 85 percent of IUCN-listed birds, mammals and plants are threatened by habitat destruction and degradation (Hilton-Taylor 2000). The greatest number of threatened species listed in the *2000 IUCN Red List* inhabit terrestrial areas. They total 9,256 highly threatened species. The largest single terrestrial group is plants, with 5,607 species; birds follow, with 1,144 species; with mammals having only slightly fewer threatened species, 1,111 (Hilton-Taylor 2000). The vast majority of threatened birds and mammals are terrestrial species. The destruction of forests is the single most important threat to birds, affecting 75 percent (BI 2000). At least 900 of the 1,144 threatened birds inhabit tropical rainforests, with almost half of those species restricted to lowland rainforests, and 35 percent in montane rainforest (BI 2000). Authors of *Threatened Birds of the World* (BI 2000) found that the vast majority--86 percent--of rainforest birds cannot tolerate much habitat destruction, and 45 percent require near-pristine habitat. Only 3 percent are highly tolerant of habitat alteration (BI 2000). Unsustainable selective logging affects 31 percent of threatened birds. In many tropical forests, logging and forest burning are taking place without any restrictions, totally eliminating habitats of rare rainforest birds. A total of 4.5 million square kilometers, or 20 percent of the world's forests, were cleared from 1960 to 1990 (BI 2000), and since then, forests--especially tropical forests--have continued their decline. Although some forests may return to old-growth hundreds or thousands of years in the future, much of the land is being converted to agriculture, grazing land, housing, cities, industry and roads and is unlikely ever to revert to forest.

Likewise, more than half, or about 57 percent, of threatened mammals inhabit tropical rainforests, 35 percent in lowland, and about 22 percent in montane rainforest (Hilton-Taylor 2000). Less than 10 percent of threatened birds and mammals are native to temperate mixed forests, coniferous forest and temperate broadleaf forests, according to the IUCN. A very small number of threatened mammals, about 3 percent, inhabit tropical degraded forest, a sign of the unsuitability of this habitat (Hilton-Taylor 2000).

Forests are also home to a wide variety of threatened frogs, salamanders, tree snails and insects, although studies of

which type of forest each inhabits have not been done by the IUCN. Many endangered plants are tropical species, native to islands such as Madagascar and Indonesia, where endemic plants such as orchids and palms abound, and habitat destruction is severe. The United States leads the world in threatened plant species, with 4,669 identified by the IUCN in its 1997 study (Walter and Gillett 1998) and 7,817 species listed by The Nature Conservancy (Stein *et al.* 2000). Many of the latter are in Hawaii, another tropical island with a high percentage of threatened plants. Lobelias are known for their beautiful flowers, and the ancestor species that arrived in the Hawaiian Islands radiated into 273 species, some of which grew to the heights of small trees. One-quarter are gone, and another 124 of the surviving species are threatened with extinction or possibly are extinct (Walter and Gillett 1998). Of the remaining lobelias, only 27 percent now have sizeable enough populations to keep them from extinction; the loss of their pollinators, most of whom were honeycreepers, is a major cause (Buchmann and Nabhan 1996). The honeycreepers lost their forest habitats to clearance by settlers, and as they faded into extinction--one species after another--lobelia plants they had pollinated disappeared or became endangered. These ecological webs exist throughout nature.

The IUCN found that 91 percent of plants identified as threatened were endemic, with their entire distribution restricted to a specific country (Walter and Gillett 1998). A total of 32,242 threatened or extinct species of plants occur in one country alone, while 2,368 occur in two countries, and only 709 plant species occur in more than two countries. Only scanty information on threatened plants is available from most countries in South America, Africa and Asia, which are expected to have large percentages of their native plants found to be threatened when assessed (Walter and Gillett 2000).

Grasslands, shrublands and savannahs are the second most important habitat for threatened birds, home to 383 species, or 32 percent of all listed species (BI 2000). Two-thirds of these birds inhabit shrublands; 43 percent, grasslands; and 8 percent, savannah (BI 2000). Three-fourths are tropical birds, whose habitats are threatened by livestock overgrazing, human settlement and farming (BI 2000). Some 17 percent of threatened mammals inhabit grasslands, while another 8 percent are shrubland species, and about 7 percent are native to desert and semi-desert (Hilton-Taylor 2000).

Freshwater habitats, such as rivers, marshes, bogs, streams and ponds are the second most important biome, after terrestrial, for threatened species. At least 1,946 threatened species, the largest number being fish (627 species) inhabit these areas (Hilton-Taylor 2000). Freshwater crustaceans (409 species) and mollusks (420 species) are major inhabitants of these aquatic areas, as are 131 amphibians, 111 reptiles, 78 birds and 31 mammals, according to the *2000 IUCN Red List*. The United States, with its extensive water projects--dams, levees, diverted and channelized rivers--harbors large numbers of threatened crustaceans and mollusks, as discussed above.

Frogs make up the majority of threatened amphibians and have been in decline for several decades. Their habitats are being destroyed at an unprecedented rate as wetlands are filled in--half of US wetlands that were present in colonial times--are gone. Thailand has lost almost all its wetlands, and Southeast Asian lakes and marshes are being drained at an unprecedented rate, threatening frogs and other wildlife. Frogs have been on Earth for 190 million years, but at the present rate of decline, the majority of the approximately 4,500 species will be gone within decades. In addition to habitat loss, a variety of threats are eliminating them (see Non-Native Species, Trade and Pollution sections below).

What is Threatening Species? Non-Native Species Introductions

Invasive species, or alien, non-native animals and plants introduced into ecosystems, present the most important threat to plants. The large numbers of threatened species that have limited distributions are highly vulnerable to the possibility of invasive species eliminating them from the wild. Islands have the greatest percentage of their native plants in danger of extinction. St. Helena, a small island in the South Atlantic, leads these in percentages, with 13

percent extinct or extinct in the wild, and 68 of 165 native plants and trees threatened (Walter and Gillett 1998). Livestock played a role in the extinctions and present status of many native plants (see Chapter 1). Mauritius follows, with 39.2 percent of native plants in danger, or 294 of 750 species (Walter and Gillett 1998). Other islands with many native plants threatened by exotic species include the Seychelles, Jamaica, French Polynesia, Pitcairn, Reunion and New Caledonia (Walter and Gillett 1998). Of the latter islands, all but French Polynesia and Pitcairn formed part of Gondwana, and many of the plants at stake are very ancient in origin.

One endemic Mauritian palm, *Hyophorbe amaricaulis*, has been reduced to a single plant. Although it grows vigorously and produces male and female flowers at different times, no fertile seeds are produced (Stearns and Stearns 1999). At the National Agricultural Station in Ireland, botanists cultivated the tiny embryonic growths found within the immature fruits; it is hoped that clones of the palm can be grown to adulthood (Parnell *et al*. 1986). Introduced animals and plants have taken over Mauritius and Rodrigues so completely that a number of species have been reduced to as few as two remaining plants.

Hawaii's native forests and plants have fared poorly, too. Native sandalwood forests were cut by early settlers, endangering several species. The most fragrant of these trees, the Iliahi (*Santalum haleakalae*), is now restricted to the dry lava slopes of eastern Maui. Its carmine red clusters of flowers have the same aroma as its fragrant heartwood (Daws 1993).

Seven or eight types of lobelia plants of the genus *Delissea* once flourished in Hawaii, and all became extinct by 1966 except one, *Delissea undulata*, which had become reduced to only a few plants. Conservationists fenced these plants in 1967 from the browsing cattle and rooting pigs, and they were thought secure (Carlquist 1980), but by 1995, the species' population had declined to a single plant. Botanists found it hanging by a few roots inside a sinkhole, the fence damaged and broken. The fence was repaired, and botanists are germinating seeds, hoping to prevent its extinction (Royte 1995). Another Hawaiian plant, *Cyanea pennatifida*, is in the same perilous status. Native to the mountains of Oahu, it also became reduced to a single plant, which was not producing its green flower. A botanist took a small sample of plant tissue and successfully cloned it in a test tube (Lipske 1997). Dozens of these plants have been cultivated from the slip, some of which were reintroduced into a preserve in 1995 (Lipske 1997).

Two hundred native Hawaiian plants are listed either on the US Endangered Species Act or are candidate species. Some 115 species have only 20 individual plants scattered in different areas or just one population of 50 or fewer plants in one location (Lipske 1997). Livestock and exotic plants have destroyed these plants and their habitats. One of these extraordinarily rare plants has been eliminated from all its original range, and the last members of the species cling to a single vertical cliff along the coast of Kauai, with its roots growing horizontally into rugged rocks (Carlquist 1980). This unusual lobelia, *Brighamia insignis*, has a thick, woody stem which tapers to a rosette of leaves, and it has lost its natural pollinator, which may have been a bird or an insect. Located 2,000 feet above crashing surf, it is out of reach of goats and pigs, but difficult for botanists to reach. This spectacular landscape is now this lobelia's sole habitat. Each year, botanists Steve Perlman and Ken Wood risk their lives by scaling the cliff, using climbers' ropes, to collect pollen from the plants with a brush. They then rappel to a neighboring plant to pollinate it, and months later, they must climb back up to collect the seeds, which are being placed into cultivation (Daws 1993; Royte 1995). Some of these seeds have successfully grown into plants at the National Tropical Botanical Garden on Kauai (Lipske 1997). This may be the most arduous and life-threatening plant conservation program in the world.

On the island of Guam, the forests have not been destroyed, but the bird life has been virtually eliminated by an insidious exotic animal that arrived in the 1960s or earlier. Several Brown Tree Snakes (*Boiga irregularis*) somehow secreted themselves in a shipment from their native Indonesia, and once on the island, they began to multiply. These snakes proved to be an environmental nightmare of the worst proportions, climbing trees and killing and consuming nestling and adult birds, and increasing at alarming rates. They have also caused major problems for the people of Guam. Ascending telephone poles, Brown Snakes short electrical wires. Between 1978 and 1990 alone, 1,000 power outages on the island were caused by these snakes (Jaffe 1994). A major threat to children, they enter homes, biting babies in cribs, and consuming pets. Untold millions of these snakes now live in virtually every environment in

Guam. By 1981, these snakes had eliminated native birds from most of the island except for a remote part in the north. The snakes obliterated nearly the entire avifauna of Guam, an estimated 750,000 birds. Once a verdant tropical island teeming with birds, the forests have fallen silent. Three birds became extinct: the Guam Flycatcher (*Myiagra freycineti*) and two distinct subspecies of birds that survive on other islands: the Guam Bridled White-eye (*Zosterops conspicillatus conspicillatus*) and the striking chestnut, black-and-white Guam Rufous Fantail (*Rhipidura rufifrons uraniae*) (Jaffe 1994). The flycatcher was the greatest loss because it left no subspecies on neighboring islands. The Guam Kingfisher (*Halcyon cinnamomina miyakoensis*) became extinct on the island as well, but fortunately, a small number had been taken into captivity. These kingfishers have been kept at several US zoos, but although they have produced some young, they have exhibited abnormal behavior, such as cannibalizing their chicks, and some have succumbed to avian tuberculosis.

The Guam Rail (*Gallirallus owstoni*) escaped extinction by a hair's breadth. The rail's population declined to about 2,000 birds by 1981, and in 1983, fewer than 100 remained; the last wild birds disappeared by 1987. The Guam Division of Aquatic and Wildlife Resources captured 19 rails in 1984 and, after captive breeding and holding, began releases in 1995 of 30 to 50 rails every three months on the neighboring island of Rota (Line 1995). Rota, a 209-square-mile island, is snake-free, but only one-fourth the size of Guam. Its forest is mainly intact (Line 1995). In 1999, the introduced Guam Rails bred on Rota for the first time (BI 2000). A small area of 24 hectares on Guam has been fenced off from snakes, and Guam Rails introduced there have also bred (BI 2000). About 180 birds survive in 14 zoos in the United States (BI 2000).

To date, no effective control has been found to rid Guam of the Brown Tree Snake. Metal bands on nesting trees of endangered birds and high-voltage electrical wires meant to kill them on contact have hardly made a dent in their populations. A native bird at the edge of extinction, the Marianas Crow (*Corvus kubaryi*), declined on Guam from 351 birds in 1981 to just seven in 1999 (BI 2000). On neighboring Rota, only 592 survived in 1995, down from 1,318 in 1981 (BI 2000). Guam still has a high percentage of forest cover and many aquatic habitats intact. Among the few mammals on Guam, the Marianas Flying-fox (*Pteropus mariannus mariannus*) has also declined, with a population in the mid-1990s of only about 300 animals. They suffered the effects of heavy hunting by the people of Guam for food, and the Brown Tree Snake is now killing juvenile bats. The endemic Guam Flying-fox (*Pteropus tokudae*) is now extinct, last seen in 1968. It was a probable victim of unrelenting hunting by natives for food but may have been killed off by the Brown Tree Snake. Shrews and other rodents and monitor lizards are disappearing from Guam as well (Jaffe 1994). Since many of the birds and bats served as pollinators of native trees and plants, these species may die out as a result.

Invasive species, mainly those introduced by humans onto islands, caused virtually all avian extinctions over the past few hundreds years. Today, almost 30 percent of threatened birds, or 298 species, are affected by introduced predators, particularly cats, rats, mongooses and other animals (BI 2000). Livestock introduced into avian habitats represents a major threat to 72 species of birds, and 71 bird species have been adversely affected by the introduction of invasive plants that eliminated the food or habitat of plants on which these birds depended (BI 2000). Pathogens, such as diseases and parasites, brought into avian habitats by various means threaten an additional 69 species of birds (BI 2000).

Introduced species threaten fewer mammals, about 69 species, or 10 percent of those listed by the *2000 IUCN Red List* (Hilton-Taylor 2000). This may be because far fewer mammals inhabit islands, compared to the number of native birds, especially flightless ones. Even sizeable islands, such as New Zealand, had very few native mammals prior to human colonization. Madagascar is an exception, with a very large diversity of primates and other mammals, a large number of which are now extinct because of invasive species, along with many other factors (See Islands chapter).

What is Threatening Species? Persecution, Hunting and Trade

A total of 367 species of birds are threatened by hunting for food (233 species) and trapping for the cage bird trade (111 species) (BI 2000). The majority of birds that are threatened by meat and feather hunting are Asian pheasants, grouse, partridges, bustards, guans, megapodes and other large birds (BI 2000). The family of birds most threatened by trapping for the cage bird trade is the parrot family, Psittacidae, with 57 percent of threatened species trapped for this trade (BI 2000). These parrots are native to Mexico, Central and South America, Africa, Asia and Australia, and some have been pushed to the edge of extinction (See Trade chapter). The Spix's Macaw (*Cyanopsitta spixii*), for example, had been reduced from several hundred birds in the wild in Brazil to a single male when he, too, was illegally trapped in late 2000. This species is now extinct in the wild.

Hunting and capture for commercial purposes threatens 212 mammal species (Hilton-Taylor 2000). Many mammals have been endangered by hunting and persecution, including a number of large predators. The number of bats on the threatened list has grown dramatically in recent years, with many fruit bats threatened by killing for food, and others by vandals or those who persecute them for supposed threats to human health. Trade affects about 29 percent of threatened mammals (Hilton-Taylor 2000). Both the Asian (*Elephas maximus*) and African Elephant (*Loxodonta africana*) species have been reduced to endangered status primarily as a result of killing for their ivory and meat. The 1989 listing of the African Elephant on Appendix I of the Convention on International Trade in Endangered Species (CITES) succeeded in putting an end to more than 90 percent of trade in ivory, which was pushing this species rapidly toward extinction. Since then, the ban has been weakened by pressure from ivory traders, and CITES allowed trade in stockpiled ivory taken from smugglers in southern Africa. This had the immediate result of increasing poaching of elephants throughout the continent, in anticipation of a lifting of the ban.

All rhinoceros species, two native to Africa and three to Asia, are critically endangered. Populations of the five species together total only about 12,000 animals, a result of heavy hunting for their horns, which are used in Traditional Medicine (TM) and as handles for daggers in the Middle East (see Trade chapter). The toll of animal species killed for meat, trade and the TM market numbers in the millions, of which a growing number are threatened. Tigers, Leopards and other wild cats, snakes, pangolins, monkeys, birds of prey, deer, seahorses, and turtles, and many other species are killed to supply this market. The Tiger is poached throughout its range because its body parts are worth $10,000 or more when sold in this market and as trophies. This species is killed in parts of its range by slow-acting poisons and leghold traps for trade, and predator control when it has hunted livestock after its natural prey was killed off. Species like the Tiger, which require large territories and are suffering high mortality from hunting throughout its range, as well as loss of habitat, are in imminent danger of extinction. Several conservation programs are attempting to stem the tide in favor of the Tiger and reduce demand for its body parts in TM. Stricter laws are needed throughout the world, however, to protect endangered animals. The bushmeat trade is a major threat to Central and West African mammals and a wide spectrum of species in Southeast Asia (see Persecution and Hunting chapter).

A thriving trade in terrarium frogs has resulted in a worldwide market for many species of these amphibians. The world's largest frog, the Goliath Frog (*Conraura goliath*) of Central Africa, weighs 7.2 pounds and reaches a length of at least 32 inches; it is found along major rivers in dense tropical rainforest in Equatorial Guinea and southwest Cameroon (FWS 1991). Throughout its range it is very rare, and it has unusual habitat requirements. It needs rapids and cascades with sandy bottoms and very clean, oxygen-rich water; deforestation has reduced this habitat. Collectors have offered huge sums up to $2,500 for capture and export of Goliath Frogs--as personal pets or for public exhibition. One US dealer imported 50 of these frogs and attempted to enter them in the Frog Jump Jubilee in Calaveras County, California (FWS 1991). The Endangered Species Act lists this species as Threatened throughout its range. The IUCN lists it as Vulnerable on the *2000 IUCN Red List*. Hundreds of other species are collected for

this trade, threatening many, including various mantella frogs of Madagascar, coveted for their golden color (See Islands chapter).

Although more reptiles than amphibians are killed for their skins, amphibians are now also being taken in large numbers for this purpose. In 1985, the United States imported more than 11,000 frog and toad hides and products worth $350,000 for the luxury trade in frog skin wallets, toad leather boots and other items (Fitzgerald 1989). Most of these skins come from a large Malaysian frog (*Rana macrodon*), but the Black-spined Toad (*Bufo melanosticus*) and other species are used as well (Fitzgerald 1989). Such products are extremely difficult to identify by species, making enforcement difficult.

Frogs are killed by the millions for high school biology class anatomy lessons, an unnecessary toll because computer programs and films now provide this information (see Projects section). For the restaurant trade, frogs are killed in even greater numbers. Indonesia and Vietnam are the major sources of frogs for restaurants and food markets in Europe and the United States. Prior to export bans, Bangladesh and India captured many millions of frogs each year for the restaurant trade. Several documentary films have recorded the process of removing the frogs' legs in Bangladesh and Indonesia; the same methods were used in each country. Once captured and gathered in large containers, the frogs' back legs are sliced off with a sharp knife or machete, and the still-living frogs are tossed into heaps, where they continue to struggle for long periods before dying. An increase in malaria was documented in Bangladesh after the frog trade caused declines in wild populations; the frogs had been controlling mosquito populations.

The Indian Bullfrog (*Rana tigerina*), a species native to southern Asia, was listed on Appendix II of CITES after heavy trade depleted it. Some of these shipments were seized: In July 1997, a shipment from Vietnam containing the legs of 450,000 Indian Bullfrogs was intercepted in Holland as a CITES violation; the container with the frogs' legs weighed almost 20 tons and was en route to a wholesaler in Canada. This shipment alone represented frogs from vast areas in Vietnam, depleting wetlands of these ecologically important amphibians. Even in US National Parks, frogs are commercially hunted. In Florida, for example, frog hunters in airboats capture millions of frogs during night hunts. In February and March 1996, 6 tons of frogs were taken from Big Cypress National Preserve for sale to restaurants and for private consumption, according to environmental groups which have petitioned the National Park Service (NPS) to end or limit this hunt (Dodds 1996).

The reptile product trade placed virtually all large crocodilians on the endangered list by the early 1970s after imports of millions of skins for luggage, shoes and handbags nearly caused extinctions of species in South America, Africa and Asia. Although controlled to some degree by CITES, a large percentage of trade is illegal, composed of protected species (see Trade chapter). The luxury trade in these products is now threatening many snakes as well as lizards, whose skins can be sold for very high prices. These reptiles, which play important roles in nature--culling rats and other rodents and preventing overpopulations of fish--are taken from the wild. Snakes are being captured in such numbers for this trade and for the Asian medicine and restaurant trades that they have disappeared from areas where they had been common. (See fiEndangered and Threatened Species of Mammals, Birds, Reptiles and Amphibiansfl in the Appendix for an extensive list of these reptiles now threatened with extinction.)

What is Threatening Species? Pollution and Disease

Pollution by acid rain and acid from coal mines that drains into streams and rivers, heavy metals, PCBs, dioxin and other toxic chemicals, have killed off all life in waterways in many parts of the world. PCBs and pesticides have caused serious genetic malformations in frogs, birds and fish.

Frogs have been dying from fungal diseases and the indirect effect of other pollutants, which are eliminating entire species. Necropsies done on frogs from Australia and Panama, which were found dying, have revealed the presence of the same fungus, chytrid (Morell 2001). It is considered responsible for the extinction of several Australian frogs, including the extraordinary Gastric-brooding Frog (*Rheobatrachus silus*) and three other species, and has infected frogs in Panama as well, eliminating populations and possibly species (Morell 2001). This fungus has been detected in 44 species of Australian frogs and is apparently spreading in many parts of the world. Other fungi and viruses have eliminated frogs in the United States (Morell 2001). These diseases have long been in the environment, and it is not yet clear why they have become so toxic and virulent to frogs. Frogs have thin skin and easily absorb chemicals, making them vulnerable, but apparently their immune systems have been weakened, as well. Frogs and toads are also threatened by pesticides, which have been shown to cause grotesque deformities and mortality. Many types of pollution, including acid rain, heavy metals and fertilizers, have eliminated frogs in many parts of Europe and Canada (Morell 2001). Ultraviolet radiation (UV) suppresses frogs' immune systems and kills eggs as well as adults. Andrew Blaustein (1994), an American biologist, conducted experiments that proved UV to be responsible for wiping out many species of frogs in the US West who laid their eggs in the open. The eggs were thus exposed to this radiation, which has intensified as a result of the decrease in the ozone layer caused by chloroflourocarbons, used by industry in air conditioners and refrigerators, among other industrial uses (see Aquatic Ecosystems chapter).

Hawaiian birds have been seriously affected by avian malaria, brought to the islands by captive cage birds, as discussed in Chapter 1. This disease continues to threaten the surviving species of native birds, and is a major cause of the wave of extinctions that is claiming one species after another of these beautiful songbirds (BI 2000). Several species, such as the Nukupu'u (*Hemignathus lucidus*), are now in Critical status, possibly extinct on both Kauai and Maui where, until the 1990s, a few birds were seen in their montane forests (BI 2000). Feral pigs in their habitats facilitate the spread of alien plants and introduced, disease-carrying mosquitoes (BI 2000).

What is Threatening Species? Traits of Vulnerable Species

By identifying the traits that characterize species likely to become endangered or fade to extinction, it is possible to afford them and their habitats extra protection and carefully monitor their status. The tragic losses of so many of these "red flag" species should be avoided in the future, and can be, with remedial action. Ideally, species should be conserved when their populations are still healthy, before they become genetically impoverished and their populations fragmented. The list below includes some of the characteristics many extinct and endangered species possess. Undoubtedly, the more we learn about the causes pushing wildlife and plants to extinction, the longer such a list will become.

1. Endemic species, or animals and plants that are restricted to a relatively small area, such as an island, are inherently vulnerable to extinction. They have incurred the greatest number of extinctions in the past 400 years. Changes in their habitat or losses to their populations can eliminate them. Many of these species were confined to areas that measured only a few square miles. Mainland species, likewise, can be endemic to small areas. The Slender-billed Grackle (*Cassidix palustris*) once inhabited a single marsh near Mexico City. The marsh was filled about 1910, spelling extinction for this bird. Many endangered species fall into this category.

2. Specialization of habitat or diet has caused much extinction. Animals that depend on a certain type of habitat or food source and cannot adjust to alterations, whether natural or human-caused, are extinction-prone. The Ivory•billed Woodpecker requires large expanses of old-growth forests with many dead and dying trees. The endangered Kirtland's Warbler (*Dendroica kirtlandii*) of Michigan will colonize only one type of forest: stands of jackpine trees that are eight to 22 years old on well•drained, sandy soil. This habitat must now be artificially maintained to prevent the bird™s extinction. The Palila (*Loxoides bailleui*), a Hawaiian honeycreeper, is dependent on the mamane tree for

feeding, which has declined as a result of logging and destruction of seedlings by introduced game species and livestock. Many endangered plants require specific soil type, climate, drainage and sunlight exposure. For those species that require unbroken stretches of habitat, such as old-growth forest, endangerment or extinction can result if the forest is fragmented.

3. Long•lived species with low reproductive rates and low natural mortality are vulnerable to extinction. Fast-reproducing species that have many young at frequent intervals and high natural mortality rates tend to be more resilient to population losses and recover quickly if their habitat has not been destroyed. Not all vertebrates fall easily into these categories, but many do, and these groupings can be at least one indication that is useful in terms of predicting which species will become endangered when their populations are reduced. Slow-reproducing animals decline rapidly from losses in their numbers, and since they often do not breed until a relatively advanced age and have few young, many decline to extinction. In some cases, such animals do not recover their former abundance, or recover very slowly. A few of these animals, including sea turtles, lay many eggs, but only a small percentage of the hatchlings survive to adulthood. Although few of the now extinct animals were ever studied in the wild, enough is known of related species to guess that many fell into this category. The Steller's Sea Cow (*Hydromalis stelleri*), for example, was a member of the Order Sirenia of manatees and Dugongs. The surviving species have few natural enemies, do not breed until age 7 to 10 years old, and have only one young every five years. Hunting caused the extinction of Steller's Sea Cow in the space of a few years, eliminating the only cold-water member of this family. Hunting threatens surviving species of this family in many areas. Manatees and Dugongs are very slow-moving, making them easy targets. The Steller's Sea Cow may have numbered only a few thousand animals in its limited distribution near islands in the Bering Sea. Even when able to swim away, they refused to leave their mates, beaching themselves on the shores next to the slain mate. Such animals can probably not tolerate any hunting. Manatees and Dugongs, likewise, need strict protection.

Many large birds, including condors, eagles and large parrots such as macaws, have low reproductive rates. The Cuban Red Macaw (*Ara tricolor*), became extinct in 1885. If its breeding biology resembled other large macaws, it was long•lived, reaching an age up to 80 years, had only one or two chicks a year and did not breed every year. Scientists have recently discovered that even in an immense national park in Peru, wild macaws produce so few young that any losses in their numbers cause declines in their populations. This helps to explain why so many birds of prey and parrots are endangered. Passenger Pigeons were long•lived, laid only one egg, and may not have nested every year. Likewise, turtles and tortoises are long-lived, with at least one species, the Galapagos Tortoise (*Geochelone nigra*) documented as living to more than 165 years in captivity. Some shark species do not breed until the age of 20 years and produce only a few young.

4. Flightless birds and slow•moving animals are helpless in the face of hunting pressure and predation by introduced predators and humans. Unwary animals, such as many island species that have evolved in the absence of predators fall into this category. Flightless birds, such as the Great Auk, Great Elephant Bird, Dodo, many Pacific Island rails and tortoises, are among species that lack defenses or cannot quickly escape predators, human or other. In addition to being flightless, many extinct birds lacked defensive behavior or the instinct to hide in underbrush as a result of their having evolved in predator-free environments. Predators introduced into their habitats, as occurred on many islands, soon eliminated them. Even the thick shells of tortoises were not effective defenses against predators such as rats, who ate young tortoises, and humans easily captured these slow-moving animals. Although our attitudes are more humane toward these vulnerable animals today than hundreds of years ago, tortoises and sea turtles are still killed for trade or by vandals for sport. Some surviving flightless birds on islands have official protection and a better future than they had in previous centuries, while others do not.

5. Large animals have been vulnerable to overhunting since the Pleistocene Epoch. In recent centuries, whales were added to the list of large species unable to escape guns or harpoons. The largest lemur and bird species of Madagascar were killed off by the Malagasy immigrants thousands of years ago, as were many large flightless birds by the Maori when they first arrived in New Zealand. Large animals are often killed merely because they make large targets or for trophies for those who enjoy slaughtering animals. Animals of large size require considerable amounts

of habitat and are, therefore, naturally more rare than species with smaller habitat requirements. When human populations rise and wilderness is replaced with towns and industry, large animals are the first to disappear, due either to loss of habitat and prey or because they are killed as potential threats. Most of the largest mammals on Earth are now on the endangered list of the *2000 IUCN Red List*, including both species of elephants, all the rhinoceros species, and many large antelope and big cats such as the Tiger, Cheetah, Leopard and Lion. They have declined from hunting or persecution and are being crowded out of their habitats by human activities. Large animals are often keystone species at the top of their food chains or play important roles in ecosystems. Their absence is indicative of damaged or incomplete ecosystems. Elephants are important in spreading seeds of many plants through their dung, and large predators play a major role in the health and physical characteristics of their prey. The African savannahs without Lions, Leopards and Cheetahs would soon be overpopulated and overgrazed by their numerous prey species. The Elk of Yellowstone National Park became overpopulated in the absence of the Gray Wolf, and grazed certain plants so heavily that some bird species and other wildlife disappeared and certain tree species became rare. In spite of the wolves™ importance to ecosystems, they are killed with impunity by livestock owners and others who consider them threats.

6. Wild animals and plants which have a value as food, pets, ceremonial objects or marketable products to humans are prime candidates for extinction. The list of animals that have been hunted to extinction for food is long. Within the past 400 years, many large land tortoises, the Great Elephant Bird, moas, Steller's Sea Cow, Auroch and Quagga were all extinguished by hunting for food. The unique Huia bird of New Zealand had plumes that were sold for large sums, helping to drive its limited population to extinction. Hawaiian songbirds were hunted to extinction for their colorful feathers, which were used in ceremonial headdresses and capes. Within the past decade, trade has increased as a threat to wildlife with the rise in Asian economies. This has fueled the Traditional Medicine markets, which consume vast numbers of animals, threatening many of them. The vacuuming of the seas by commercial fisheries has resulted in depletions and endangerments. The once abundant sturgeon of the Caspian Sea, for example, sources of Beluga and other expensive caviar, are now critically endangered as a result of unrestricted fishing and poaching for the luxury gourmet market. The bushmeat markets of West and Central Africa sell tons of slaughtered monkeys, forest antelope, Chimpanzees, Gorillas and other wildlife, devastating species whose tropical forest habitats are being logged. Hunting for food is also a major threat as firearms become available to native peoples who once used primitive weapons. Southeast Asian wildlife is under siege by people who once hunted only for their own purposes but now find that a wide range of wildlife can be sold in local meat markets or for Traditional Medicine. They set nooses and traps, killing rare monkeys and antelope, birds, snakes, turtles and tortoises, pangolins and lorises, clearing out the forests of wildlife. The pet trade is driving many colorful tropical birds, reptiles and primates to endangered status. Luxury goods, such as high-priced reptile products, provide an incentive to hunt--legally or illegally--lizards, crocodiles and snakes for this market, endangering many species. Trophy hunting of endangered species by wealthy hunters is a major threat to a growing number of animals, especially since the largest specimens are killed; these are the ones that should be left to breed. The higher the value of the animal or product, the greater the threat to that species.

7. Altruism, or the unselfish care for members of one's own species, highly admired as a human trait, has been fatal to many animals--the Passenger Pigeon, Dodo, Carolina Parakeet and Steller's Sea Cow, for example. In their evolutionary history, this behavior served to preserve bonds between animals and to frighten off predators. When confronted with guns or other weapons wielded by humans, however, animals that come to the aid of fallen mates or flockmates can be easily killed themselves. Refusal to leave their wounded fellows hastened the extinction of many species. Endangered species with these traits include wolves, gorillas, whales and elephants.

8. Species breeding in colonies or requiring large numbers of their own kind for protection, to locate food sources or for other means of survival, are vulnerable to extinction. The Passenger Pigeon was a colonial nesting bird and could only survive among large numbers of its own species, flocking and seeking food sources over large areas. When flocks were fragmented, these separated populations declined to critically low levels, even though their total numbers may have been in the tens of thousands. The Passenger Pigeon may have become critically endangered as soon as its migrations, feeding and nesting behavior were interrupted, even though it appeared to observers at the time

to be plentiful. These pigeons had longevity of several decades, and failure to reproduce would take some time to be noticed in the overall population. But when there is little or no introduction of young into a population over a period, it can suddenly crash with little warning, as the Passenger Pigeons did. Wild parrots tend to feed, roost and spend their time preening and in courtship as a flock. For some species, these flocks number in the thousands of birds. When netted or caught by various means for the pet trade, which threatens a large number of species, their flocks are broken up and they are no longer able to function as a group. Their breeding is curtailed or stopped altogether, and they may no longer fly in groups seeking fruiting trees or mineral licks when they fear being captured. Flamingos require large numbers of their own kind for feeding, flocking, migrations and breeding, and their populations crash if any of their survival requirements are not met.

Many species of birds have breeding strategies in which male birds will not breed unless they are able to display courtship behavior in the company of other males, vying for the approval of females. Birds of paradise, cocks•of•the•rock in South America, prairie chickens and grouse of North America are among birds that display for the benefit of females, who choose among them. Such birds require specific conditions to breed, and habitat alterations, reductions in their populations or hunting pressure that keeps them from exposing themselves in the open can prevent their breeding.

Mammals, reptiles and amphibians also have male contests of strength, agility or other mark of superiority of species. Wild sheep and deer vie for females by head butting and challenging one another. Many types of tropical frogs emerge during the breeding season to form groups that display to one another for the benefit of females. Male Plowshare Tortoises joust with one another in attempts to upend the rival and will not breed if only a single male and a female are placed together. Without rivals for competitions, male breeding behavior may not be triggered, preventing reproduction.

Zoos and zoologists are only beginning to understand some of the instinctive responses necessary for breeding. Our traditional concept that a compatible pair of animals will reproduce is often incorrect, and populations of animals must not be allowed to be so reduced that their natural breeding behavior and other survival needs are not met.

Thus, while population numbers can provide important information about the status of a species, without additional information, such as the traits mentioned above, the data can be extremely misleading and inapplicable. The number of individuals surviving in a species, when known, must also be placed into a context greater than their rate of decline and habitat status. Unless the entire breeding biology, behavior and other aspects of species' survival needs are taken into account, extinction cannot be predicted, or status properly evaluated.

Some species now extinct suffered from several of the above factors, which hastened their extinction. The Passenger Pigeon, for example, required enormous amounts of food, mainly from nut-bearing trees in old-growth forests, and was relatively long•lived, killed for food and commercial sale, and lived colonially. Elephants and manatees are among endangered species with many vulnerable traits, including large size, altruism, slow-reproduction, low natural mortality and longevity. They are also slow-moving and valuable in trade and as food sources.

These traits indicate only vulnerability to extinction caused by humans, not species likely to become extinct through natural selection. Sea turtles, for example, have lived on Earth for more than 200 million years. By any standard, they are a superbly successful, adaptable species that, prior to recent exploitation, showed no signs of decline. Their vulnerability lies in their inability to flee rapidly in the water or while laying eggs onshore when preyed on by humans.

Many endemic species occupy very limited habitats and have small populations but have not been listed as threatened if their environments or populations have not declined. The majority of these species have prospered for thousands of years in stable environments, and only the intrusion of human-related activities and domestic animals upset this equilibrium. Such species are extremely vulnerable to even minor habitat destruction or hunting pressure

and should be carefully monitored for losses in their populations.

Because of human technology and weaponry, all animals have become vulnerable. Animals that for thousands of years used natural camouflage, stealth and intelligence to escape from natural predators, have become easy prey for human hunters and fishermen. Predators, never in their evolutionary history preyed upon, now find themselves targeted by hunters, trappers and poisoners. Sonar locates fish schools and whales, and heat detectors and night-view binoculars observe animals in darkness. Cleverly constructed blinds hide hunters from view. Animal scents are used to lure wildlife, and hunters imitate animal sounds or use tape recordings of their calls to lure them to traps or within shooting range. Some hunters use the signals emitted by radio transmitters placed in wild animal collars by biologists for tracking, to hone in and pursue them to their deaths. Guns equipped with telescopic sights can fire at targets mile away, killing animals before they are even aware of the hunter. Other weapons include sophisticated traps, nets, snares, guns, harpoon guns and high•speed vehicles and boats, with which people can run down, maim and kill even the swiftest and most intelligent animals. These devices give humans such an advantage that they render the natural protections animals have evolved over eons completely ineffective. Hunters are able to kill the fittest and strongest specimens through these means. In the process, we are changing the course of evolution from survival of the fittest to survival of animals that are tolerated by humans and those able to persist in an increasingly polluted, damaged and ecologically impoverished natural environment.

Those species whose populations have become greatly reduced are vulnerable to extinction through genetic impoverishment and inbreeding. Such species usually remain rare or gradually fade into extinction as fertility declines. The critical low level which results in extinction is different with each species and cannot be predicted with certainty.

Just as the story of North America's lost species and environments is illustrative of many similar tragedies, the account below of the civil war in Rwanda and the former Zaire encapsulates the major threats to wildlife and the environment. It also makes abundantly clear that the survival of humans, animals and the environment are intrinsically linked. The influence of countries that contribute foreign aid to poor nations half a world away, and interfere in their politics, is another important element that can greatly affect the survival of wildlife and the natural world.

Human Tragedy and the Looting of Virunga's Treasures: Page 1

The mist•enshrouded Virunga Mountains of East Africa tower over dense highland vegetation. Far below, crystalline lakes ringed by marsh reeds glisten in the sun. Shy forest African Elephants walk along mountain paths in single file. Groups of endangered Mountain Gorillas (*Gorilla gorilla beringei*) feed in forest glades. Three hundred fifty of these magnificent animals, almost half their world population, reside here (Fisher 2001). The western edge of these mountains is protected in the vast 12,800•square•mile Virunga National Park, bordering western Rwanda. Some 766 species of birds reside here, more than are native to the United States and Canada combined. Iridescent sunbirds feed on the flowers of giant lobelias, and more than 200 species of mammals live in the park (Bonner 1994). Many of the species native to the park are found nowhere else on Earth. This ecological treasure is Africa's first national park, set aside in 1925. Virunga was closed to visitors other than scientists until very recently. In the 1970s, it became a World Heritage Site, a designation by the United Nations Educational, Scientific and Cultural Organization (UNESCO) for places deserving special recognition and protection.

In the early spring of 1994, political upheaval in the region caused a civil war that wreaked massive ecological damage and loss of wildlife in this natural paradise. Rival tribes in neighboring Rwanda clashed violently after the country's President was killed in an airplane crash caused by a rocket launch (Wright 2001). There were suspicions

that his death had been arranged by his enemies. In an attempt to overthrow the minority-run Tutsi government, the Hutu majority began slaughtering Tutsi tribal members. Within months, more than 500,000 people, most of them Tutsis, were slaughtered in an appalling genocide that began with armed conflicts between army soldiers and rebels and accelerated to violence between neighbors. People of all ages were victims, many killed by slashes from machetes or battered to death with clubs. The Hutu failed in their attempt to overthrow the ruling Tutsi tribe and fled in panic west to neighboring Zaire, home of Virunga National Park.

Some 2 million Rwandan Hutu refugees flowed in a steady stream into eastern Zaire, just south of the park. Injured and starving, they crowded into camps where international aid organizations fed them and attempted to control cholera and other infectious diseases. Within days, scenes that might evoke visions of Dante's *Inferno* were televised by news organizations to viewers around the world. Gaunt, frantic people were seen scrambling frantically for food supplies or lying listlessly in the final stages of starvation and disease. Estimates of total mortality from the war, starvation and disease exceeded 1 million people (Wright 2001). Many of the surviving refugees were afraid to return to Rwanda and remained in the refugee camps or built settlements on hills near Virunga National Park. To supply firewood to these 700,000 or more refugees, 30,000 people went into the rainforest each day, cutting down tens of thousands of trees (Bonner 1994). Rwandan soldiers and others began a thriving business selling firewood throughout the refugee camps. By November 1994, 112 square miles of the park had become partly or completely deforested, and little was done by Zairean troops or park authorities to curb the destruction (Bonner 1994). One forest ranger said, "Trees used to block the views everywhere. Now I see hills I didn't even know existed." An estimated 230 truckloads of trees left the park every day (Salopek 1995).

In December 1994, the World Heritage Committee placed Virunga National Park on a list of "World Heritage in Danger.fl Along with the forest cutting, park wildlife was killed for food by both refugees and Zairean soldiers, who had gone unpaid for months by the failing government. In mid-1995, more than 12,000 of Virunga National Park's Hippopotamuses (*Hippopotamus amphibius*) were killed for their meat and their ivory teeth, reportedly by Zairean soldiers using semiautomatic weapons. By late September 1995, there were still 700,000 Rwandan refugees camped near the park, removing 600 metric tons of firewood from the park each day (Lang 1995). Michel Leusch, Environmental Coordinator for the United Nations High Commissioner for Refugees in nearby Goma, said, "The quantity of biomass may be recovered in time, but some things, like rare plants and animals, have disappeared and cannot be replaced" (Lang 1995).

The government of Zaire began closing refugee camps in January 1996, with more than 1 million refugees still resident in 40 camps along the border with Rwanda. Another 700,000 Rwandan refugees stayed in camps in Tanzania and Burundi (McKinley 1996). Although millions of dollars were donated to supply food and medication, no aid funds were allocated for alternate fuel for these refugees, such as solar cookers and propane gas stoves that would have helped prevent the devastation of Virunga's forests. This highlights the need for an international ecological rescue fund that could ameliorate such tragedies, as well as safeguard wildlife from slaughter. In late 1996, Zairean troops attempted to force the last of the Rwandan refuges back into their country, causing open warfare to break out, and the last of the United Nations relief workers were forced to abandon the area. By mid-1997, hundreds of thousands of Rwandan Hutus had dispersed through the forests of Zaire, living off the land. Thousands of Hutus, jailed on their return to Rwanda, were placed on trial in an international tribunal in 2001 for their actions during the massacre.

Human Tragedy and the Looting of Virunga's Treasures: Page 2

A major underlying cause of Rwanda's civil war and the great suffering of its people is its uncontrolled population growth. In 1973, Rwanda's population reached 3,980,000 in a country whose total area is only 10,169 square

miles--smaller than Maryland (Anon. 1975). This resulted in a ratio of 391 persons per square mile, one of the densest in the world. Populations continued to grow, however, and by 1992, they topped 8,206,000, with a density of 806 persons per square mile (Anon. 1994a). The country became increasingly crowded, as arable land became scarce. Competition for land had become intense. Much of Rwanda is eroded and barren, the thin tropical topsoil producing crops for only a few years after the forest has been cleared. Only 22 percent of the land remains forested (Wright 2001). Farmers slash and burn more forest for planting when land ceases to produce crops or grazing grasses. Steep, erodable slopes are being plowed right up to the limits of protected parks and reserves. The feuding between Hutu and Tutsi might have been peacefully settled if not for the extreme poverty and overpopulation. The average per capita income in 1999 was $720 per year (Wright 2001).

The war™s massacres killed almost 1 million people, leaving an estimated 7.2 million people by 2,000, according to unofficial estimates (Wright 2001). Unless birth control becomes widely accepted in Rwanda, human populations will rise to an estimated 11 million people within a few decades. Some experts believe that nearly 22 million people will occupy Rwanda by 2020 (Anon. 1994a). By the latter estimate, there will be 2,163 persons per square mile in Rwanda, far more than its land can support. By contrast, the population density in the United States in 2000 was 76 persons per square mile, and Canada's, 8 persons per square mile (Wright 2001).

Human Tragedy and the Looting of Virunga's Treasures: Page 3

The effects of burgeoning human populations on wildlife and the once magnificent forests that covered the region have been tragic. Long before the forests of the Virunga Mountains became divided into the separate countries of Zaire, Rwanda and Uganda, and before the forests were replaced by agriculture in the latter two countries, thousands of Mountain Gorillas inhabited the region. As human populations rose, Gorillas declined to their present endangered status. These peaceful primates wander in the forest throughout most of the daylight hours, feeding on the luxuriant vegetation. As the largest and most powerful of all primates, the Gorilla male has an enormous chest, 20 inches across and up to 5.7 feet (1.75 meters) in circumference. He weighs up to 605 pounds, while females are much smaller, about half the weight of the male (Nowak 1999). The Mountain Gorillas' forests can become quite cold at night, and to adapt, they have developed longer, thicker hair than the Lowland and other races of Gorillas.

Gorillas travel in family groups led by silverbacks, named for the whitish-gray hair on their backs. These are the strongest and largest males, usually more than 20 years old, who guide and protect the band. Males compete for this role as soon as they are teenagers. Silverbacks father the babies in the family group, although sometimes females mate with "outside" males. These groups often travel long distances to locate fruiting trees and edible plants and tubers. Almost entirely vegetarian, Gorillas eat 40 pounds of food a day, feeding on 70 or more species of leaves, bark, fruit, roots, fungi, flowers and bamboo. They rarely drink water, obtaining moisture from the dew-laden plants, and the only animal matter they consume consists of insects. Gorillas consider army ants a delicacy and occasionally eat grubs and other insects.

In Rwanda's north, contiguous to Virunga National Park, where about 250 Mountain Gorillas survive, Volcanoes National Park, a 48-square-mile forest reserve, is home to about 100 Mountain Gorillas (Fisher 2001). The latter forest was once much larger, but the needs of agriculture had greater priority, and some 65 square miles were carved out of the park, squeezing the Gorillas into a fraction of their original range in the country.

Human Tragedy and the Looting of Virunga's Treasures: Page 4

In neighboring Uganda, the small Mgahinga Gorilla National Park, a 34-square-kilometer reserve, protects 40 more Mountain Gorillas. Some 25 kilometers north is a beautiful cloud forest, Bwindi Impenetrable Forest National Park, covering 330 square kilometers, in an area of high biological diversity (Butynski and Kalina 1993). This forest has the greatest number of trees of any in East Africa and so many endemic plants that it has been selected by the IUCN Plants Programme as one of Africa's most important forests (Butynski and Kalina 1993). Birds, butterflies, amphibians and reptiles found nowhere else inhabit the Bwindi Impenetrable Forest. It also protects a population of 300 Mountain Gorillas who have smaller bodies, longer limbs, hands and feet than those of Zaire: Their skulls and trunks differ also, and they are somewhat different genetically from other populations (Croke 1995, Drewes 1997). Scientists are now considering naming these Gorillas a separate subspecies. Destruction of forest and other habitats outside Uganda's and Rwanda's parks is extensive, making these last natural areas crucial to the survival of the Mountain Gorillas.

Uganda's decades of chaos under President Idi Amin decimated the wildlife of this lovely country bordering Lake Victoria. Murchison Falls and Queen Elizabeth National Park once had magnificent concentrations of elephants, hippos and other large mammals, but by 1997, little remained, having been slaughtered by rebel groups or refugees from neighboring countries (Drewes 1997). Uganda's Ministry of Tourism, Wildlife and Antiquities conducted an aerial survey of Uganda's remote northern regions to determine whether some wildlife might remain to restock other areas, but they found "absolutely nothing" (Drewes 1997). Uganda has recently made a commitment to restore its wildlife and has reintroduced many large ungulates, trucked in from Kenya, into its national parks.

Human Tragedy and the Looting of Virunga's Treasures: Page 5

Although Gorillas share more than 98 percent of human genes, making them, along with the two species of chimpanzees, our closest relatives, until the 1960s, they remained mysterious, threatening creatures in the view of the public, depicted as monsters in movies. During the 19th century, explorers and hunters killed them as ferocious symbols of savagery. The work of American biologists Dr. George Schaller and, later, Dian Fossey, who entered the forests of the Mountain Gorillas as observers and researchers, changed this image forever. Films and books of the National Geographic Society and others revealed the gentleness and intelligence of these magnificent primates to people around the world, and gradually, conservation programs began to replace trophy hunting.

Schaller, who began his research in the 1960s in Virunga National Park, wrote about these primates in *The Mountain Gorilla*, published in 1963 by the University of Chicago Press, and a popular version, *The Year of the Gorilla*, in 1964. He provided the first scientific observations of these remarkable animals and recalled his encounters with them in a 1995 *National Geographic* article:

> *I approached them with empathy and respect, wanting nothing from them but peace and proximity. And they accepted my presence with an astounding generosity of spirit. The recent decades have been a turning point, indeed a revolution, in our relationship with animals. Humans have begun to overcome cross-species barriers, achieving intimacy with humpback whales, chimpanzees, lions, mountain sheep, wolves. The gorillas of popular image were a fantasy . . . No one who looks into a gorilla's eyes--intelligent, gentle, vulnerable--can remain unchanged, for the gap between ape and human vanishes; we know that the gorilla still lives* within us. Do gorillas also recognize this ancient connection? (Schaller 1995).

In the 1960s, Virunga National Park sheltered the largest population of Mountain Gorillas, numbering some 450. They declined to 275 by the 1970s, and to 250 by 1981, a result of poaching. The Mountain Gorilla Project, begun in 1978 by Schaller and a consortium of conservation organizations, including the New York Zoological Society and the African Wildlife Foundation, sought to stop the Gorilla's decline toward extinction. Funding went toward anti-poaching programs, education of local people, and ecotours (Schaller 1995). With non-threatening visitors to the park, many Gorillas grew tame. They were given names by park rangers and scientists and became familiar to tourists who came from around the world to see them. The conservation program and ecotourism succeeded in nearly eliminating poaching, and Virunga's Gorillas increased to 320 by the late 1980s (Schaller 1995). The Gorilla Project also operated in Uganda, where the government ejected 2,000 farmers from 3,500 acres, offering to compensate them with 10 percent of the revenue from tourists who come to see the gorillas (Salopek 1995).

Human Tragedy and the Looting of Virunga's Treasures: Page 6

Fossey's early research was sponsored by the famed anthropologist Louis Leakey, who had earlier convinced Jane Goodall to go to Tanzania to study Chimpanzees (*Pan troglodytes*). Both researchers changed forever our views of these fellow primates. Fossey began her research in the 1970s in the mountains of Rwanda, making friends with a family of Mountain Gorillas. The silverback male of this troop, whom she named Digit, became so trusting that he was filmed by the National Geographic Society gingerly taking her pen and then her notebook, returning them to her, and then lying down and going to sleep by her side (see Video--Mammals). These immensely strong animals never harmed any of the thousands of people, from rangers and scientists to tourists, who visited the reserve over several decades. When they felt their family was threatened, they made shows of aggression, pounding their chests or rushing headlong through the bushes toward the potential threat, whether human or another male Gorilla, but stopping short of physical blows. Humans, however, misinterpreted their displays, shooting and killing many silverbacks.

Commercialization of Gorillas--the high value of their young in the exotic pet trade and the many thousands of dollars offered by zoos to obtain illegally captured specimens--has presented a major threat to the species for many decades. Local people enter parks and reserves to shoot adults guarding the young, remove the animals™ heads and hands, and grab the traumatized babies. Other Gorillas are killed accidentally by illegal wire snares set in the parks for antelope and small mammals. Although efforts had been made in many parks to stop the killing of Gorillas, not until December 1977 did international attention become focused on this grisly and cruel activity. Six Rwandans, with their hunting dogs, entered the reserve armed with spears to kill Gorillas. They encountered Digit, who boldly rushed at them, pounding his chest. This allowed his family to escape, but cost him his life. The Rwandans speared him five times until he died, and then cut off his head. Gruesome photos of Digit's headless body received enormous publicity in the media, causing shock and dismay in millions of people who had seen photos of him in gentle communication with Fossey, as well as films produced by the National Geographic Society about her research. His death served to inspire both compassion and renewed conservation efforts for these beleaguered primates.

Fossey's Karisoke Research Center expanded, and thousands of tourists came to glimpse the Mountain Gorillas in their forest home. The threat of poachers remained, however, and Fossey, after a fervent campaign to prevent further Gorilla killings, was herself killed. Her murder has never been conclusively solved, but Rwandans are the major suspects. She is buried in the reserve next to the grave of Digit. Fossey recounted her experiences with Gorillas in a book, *Gorillas in the Mist*, which was later made into a commercial film of the same title. The silverback star of this film was named Mrithi. Not long after the film was made, in May 1992, he, too, was shot and killed by Rwandan soldiers, surrounded by his family of 11. Even after being wounded, he managed to drag himself some 6 feet toward his attackers before collapsing and dying.

Human Tragedy and the Looting of Virunga's Treasures: Page 7

During the 1980s, the country of Rwanda had adopted Mountain Gorillas as an international symbol of wildlife protection during the 1980s, and when civil war broke out in the spring of 1994, both sides promised to spare them--promises that were not kept. In April 1994, the Rwandan civil war forced the staff of biologists at the Karisoke Research Center to depart (Perlez 1994). By early July, most of the wardens of the Rwandan Office of Tourism and Volcanoes National Park fled also, but a few dedicated guards refused to leave the Gorillas and remained. Soon after, Rwandan soldiers entered the park and ransacked the offices, destroying records and books and throwing computers out windows but, fortunately, sparing the lives of the guards and the Gorillas. The war claimed at least one Gorilla that year, however, when a male named Mkono was killed by a buried land mine (Tuxill 1997).

The staff of Volcanoes National Park was devastated by the war. Two-thirds of Rwanda's park employees died or remained in exile after the war ended, and 48 of 50 vehicles were destroyed (Salopek 1995). When surviving employees returned, many of them having been rescued from the masses of people living in refugee camps, with the help of United Nations personnel, they were delighted to see the Mountain Gorillas again. Nshogoza, a park employee who has spent 18 of his 44 years at Karisoke and has known generations of Gorillas, told a *National Geographic* writer, "When I was a boy, I heard that gorillas were men who were very bad and who went to live in the forest. But the gorillas are better than us. They are peaceful. They have no tribes. When they fight, it is for a good reason. We cut one another with machetes for zero" (Salopek 1995). To honor these guards, the park received the $50,000 J. Paul Getty Wildlife Conservation Award in May 1996, the money to be managed by the International Gorilla Conservation Program. Some was spent detecting and defusing more than 75 mines and booby traps left after the war, and other funds restored tourism in the park.

The Mountain Gorillas of Virunga National Park had been safe for a decade, but in 1995, Rwandan refugees, probably members of the routed army, entered their misty, forest home. In August and September 1995, three Gorillas--two silverbacks and one female--were found shot to death at point-blank range. One of these, named Marcel by the park scientists, was the most popular of Virunga's Gorillas, totally tame and gentle. He was so habituated to tourists that they could approach within a few feet of him, and hundreds of films and photos had been taken of him over the years. The bodies of Marcel and his mate were found sprawled out on the ground, full of bullet holes. "If someone comes in with a gun, the gorillas won't move out of the way," said Popol Verhoestraete, a field officer for the conservation program (Lang 1995). The killers left the bodies intact. These two Gorillas died trying to save their baby from poachers, who allegedly planned to sell him to a zoo. The park guards finally located this young Gorilla and seized him from the poachers, who were arrested. They carried the baby, who had become terrified and disoriented, in a small cage back to the family group. Not knowing if the frightened young Gorilla could survive without his parents, they released him, prepared to recapture him if things did not go well. After hesitating, he heard the sounds of his family and ran to join them. The leaderless and traumatized family group moved off into the forest.

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Illegal snares have been threatening wildlife in these parks for generations. In the 1960s, Schaller saw two Gorillas in a group of 11 that had each lost one of their hands to snares (Schaller 1995). In Virunga National Park in mid-1995, a young male Gorilla was seen with a wire snare wrapped tightly around his foot, cutting off circulation, which threatened his life with septicemia (Salopek 1995). Just as the guards were preparing to capture him to remove

the snare, they saw a huge male silverback watching over him. They waited until the right moment and darted the young Gorilla with a tranquilizer, taking him to a local veterinarian, who saved the Gorilla™s foot (Salopek 1995).

In another snare incident in 1995, a very young female Gorilla was caught by the wrist in a snare set by Rwandans who entered Virunga to trap forest antelope. A film by Bruce Davidson, "Mountain Gorilla," shown on the fiNational Geographic Explorer" television series (September 14, 1996), chronicled the trauma of this tiny Gorilla, who struggled in vain to free herself, crying out and screaming in fear and pain. The park rangers thought that she might have been in the snare, which was tied to a tree, at least 24 hours before they discovered her. She was surrounded by her family, but her relatives could not bite through the snare because it was made of strong nylon cord from food sacks donated to the refugees. The silverback male, Ndingutse, tried again and again to free the baby, and her mother held her to comfort her screams, but there was nothing they could do to release her. Finally, the park guards, who had been standing nearby, were able to approach when Ndingutse moved away for a moment, and cut the cord. She escaped, but faced the threat of becoming snared again, and the cord remained around her wrist, a threat to her circulation as she grew.

The snares are usually attached to bamboo poles, bent over to spring when set off. Davidson filmed Ndingutse's brother, a 7-year old named Luwawa, in an extremely intelligent and protective reaction to a snare he encountered. When Luwawa saw the snare, he circled it, obviously aware of what it was. Waiting for the rest of his family to arrive and witness the act, he reached over and snapped the pole like a twig, avoiding the noose and disarming it. Against guns, he had no defense, however. Soon after, Luwawa was found shot dead on the slopes of Virunga National Park. His brother Salama had been killed months earlier. Only his bones and skull, picked clean of meat, remained when park rangers found him. The slaughter of these silverbacks traumatized the five to 10 females in their groups and left the babies and young without a strong male to protect them. They became shy and confused, hiding from humans, and even other Gorillas. In 1996, another two Mountain Gorillas were killed, bringing the toll for the previous 17 months to 10, causing havoc and psychological trauma in the families left behind and irreparable genetic damage to these highly endangered animals. In neighboring Uganda, more of these gentle Gorillas died--four adults in Bwindi Impenetrable Forest were speared to death by poachers in 1995 (Salopek 1995). The expulsion of farmers to enlarge the park for Gorillas caused great resentment, and perhaps precipitated this carnage. Tourists who came to see the Mountain Gorillas in this new Bwindi National Park in March 1999 met disaster when Hutu rebels ambushed and killed eight people in one group. This was thought to be the end of Mountain Gorilla tourism in Uganda, but with increased protection of tourists, they are gradually returning. Poaching declined after the deaths of Gorillas and tourists, and by 2000, the Mountain Gorillas in the Virunga Mountains in both parks totaled 358 (Fisher 2001). Tourists coming to Rwanda's Volcanoes National Park are still in some danger when not in groups guarded by soldiers, however (Fisher 2001).

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The fact that Gorillas are gentle, kind and intelligent beings makes these cruelties all the more horrific. Millions of people saw a television report on August 16, 1996, showing Binty, a female Lowland Gorilla at a Midwestern US zoo, saving a little boy who had fallen into the exhibit and was lying unconscious; she picked him up and carried him gently to a door where keepers entered, setting him down in front of it. People were overwhelmed by her act of good will, as well as by her quick reaction. Many viewers had no idea that Gorillas would want to help a human in need, nor that she would use such good judgment in rescuing the boy, who recovered completely.

Koko, a captive Lowland Gorilla taught American Sign Language by Francine Patterson, president of the Gorilla Foundation, has learned some 800 signs and uses descriptive, imaginative language in naming unfamiliar objects, such as "finger-bracelet" for ring. She also paints, and when asked what one of her more colorful creations (reproduced on

page one of *The New York Times*) depicted, she signed "bird" (Boxer 1997). We are only beginning to learn about these primates, but without strong protection, they may soon become extinct in the wild at the hands of humans.

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Many Africans have little respect for Gorillas. Hunters in Cameroon, when asked by researchers why they shoot Gorillas, replied "What's wrong with killing a Gorilla? They're fierce." One of the hunters told reporter Michael McRae that he was sure Gorillas were plentiful: "In Cameroon there are a million Gorillas. Three weeks ago, I saw sixty in one day. I shot three and then stopped . . . Why should I feel bad for a Gorilla? He is just a stupid animal" (McRae 1997). Education and an alternate source of income might change the opinions of these hunters. They have the same views Westerners had before research studies and films introduced people to the true nature of these primates.

As far as their abundance, there are hardly a million Gorillas in Cameroon, in all of Africa or the world. Gorillas are declining toward extinction. Their total population is estimated at well under 100,000 and declining (McRae 1997). The Lowland Gorilla and Mountain Gorilla are considered separate species by the *2000 IUCN Red List*, and both are classified Endangered. The US Endangered Species Act considers Gorillas to be a single species (*Gorilla gorilla)* and lists them as Endangered. Likewise, CITES lists Gorillas as a single species on Appendix I. The species is officially protected from hunting throughout its range, but national legislation is almost never enforced. The Lowland Gorilla is declining rapidly as a result of logging, killing for the bushmeat trade, and possibly ebola disease. Adults are often killed to obtain babies, which are traded on the black market to zoos in many countries. Hundreds of Lowland Gorillas are being slaughtered in Cameroon and other parts of their range, causing immeasurable trauma and cruelty to their close-knit societies, as well as ecological harm. The Moabi tree, a very important species for its fruits, seed oil, bark and wood, produces enormous seeds that Gorillas disperse (Tuxill 1997). African Forest Elephants are also crucial to the survival of Moabi trees, spreading their seeds, and they, too, are threatened with extinction.

The bushmeat trade is wiping out many other species of wildlife in wide areas around African villages. People set wire snares throughout the forest, into which rare deer, antelope, primates, wild pigs and a variety of animals blunder, struggling for days in great pain until the trappers arrive to kill them with knives. Even apart from the cruelty and conservation issues, the bushmeat and pet trades are not even lucrative. People make only a hand-to-mouth living from them, selling rare apes for a few dollars to traders, and other animals for a few cents. They are killing off their wildlife heritage while remaining in poverty.

Local people receive almost no benefit from logging, which is permanently devastating the old-growth forests. Tourists do not want to visit logged-over areas which have a fraction of the wildlife of unlogged forests and, in the case of clearcutting, an ugly, barren landscape. Trophy hunting, which is increasing in rainforests of Africa because of lobbying by the Safari Club and other organizations, is further reducing the wildlife. These hunters kill the largest and rarest animals--the prime specimens that should be left to perpetuate the species--and cause wildlife to become frightened and shy.

Mountain Gorillas are not killed for the bushmeat trade, but are shot for their body parts. None exist in captivity. These endangered gorillas are monitored within Rwanda's Volcanoes National Park by numerous researchers of the Karisoke Research Center, run by the Dian Fossey Gorilla Fund International. They are conducting a variety of different projects studying breeding, genetics and other aspects of their lives. One researcher noted the extreme devotion the Gorillas have for one another. Amahoro, meaning Peace, a 14-year-old silverback in the park, became lethargic and could not keep up with the group (Williamson 2001). Another male became his constant companion, and sometimes two males helped him along. The International Gorilla Conservation Programme was contacted for

veterinary assistance. A veterinarian arrived and examined Amahoro from a distance, because he was defended by two other males (Williamson 2001). The next day, he was barely able to move and began coughing; the troop gathered around him, chest-beating in anxiety (Williamson 2001). After calls to gorilla veterinarians in the United Kingdom and the United States, the veterinarian decided that his problem was an infection in need of antibiotic treatment, which was administered by dart; he recovered fully (Williamson 2001).

Because of the international importance of the Mountain Gorillas and their precarious status, researchers from the National Aeronautics and Space Administration (NASA) began scanning their habitat in August 1994 during a 10-day environmental space satellite mission (Anon. 1994b). Overlaying the NASA images with data collected from navigation satellites and standard topographical maps is now providing an extremely detailed overview of the Mountain Gorilla's habitat. The habitat now protected totals only 285 square miles, not a large area for the 658 remaining Mountain Gorillas.

One wonders what their lives were like thousands of years ago when they roamed over vast, montane forests undisturbed. They may have shown behavior that has disappeared under these new conditions. During some parts of the year, they might have frequented the lowlands, feeding on trees or other vegetation that has long ago disappeared, replaced by farmer's fields. It is possible that they are not receiving adequate nutrition from the plants in their reduced habitat. Their restricted ranges may be causing inbreeding. These Gorillas have suffered great psychological harm from the constant threat of death from hunters, never knowing when they may be confronted and killed. The loss of many family members to snares and shooting traumatized these sensitive and devoted primates.

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Another important Gorilla habitat in southern Zaire was invaded by many of the 400,000 Rwandan refugees who fled to this area in 1994. This magnificent protected area--Kahuzi•Biega National Park--covers some 2,085 square miles (Jay 1994). It is also a World Heritage Site. The large mammals of this park were surveyed in 1994 by the Zairean Institute for the Conservation of Nature and the Wildlife Conservation Society (Jay 1994). Preliminary data indicated that the rare Grauer's Gorilla (*Gorilla gorilla graueri*), a subspecies of the Lowland Gorilla, was found in fairly large numbers--at least 1,000 animals (Jay 1994). Elephants were also numerous (Jay 1994), and the park has many rare birds (Collar *et al*. 1994). One camp of 50,000 refugees blocked a narrow corridor of forest that served as a migration route for elephants and lone male Gorillas between major sections of the park (Jay 1994). The Wildlife Conservation Society conducted a long-term study of the effects of hunting on wildlife in the park, supplemented by a 10-month United Nations probe, which released a report in April 2001 (Lauria 2001). Gorilla numbers have plummeted here also, killed for food and trophies. As ABC News filmed one of the few remaining Gorilla families in Kahuzi-Biega National Park during the summer of 2001, a male Silverback charged the camera crew. Only a decade ago, Gorillas were tame and securely protected in this area. The UN investigation determined that Rwandan forces and others have slaughtered all but two of 350 elephant families in the park for the illegal ivory trade (Lauria 2000). This poaching was part of an organized network of corruption now looting parks and natural areas in the renamed Democratic Republic of the Congo of diamonds, gold, timber and wildlife (Lauria 2001).

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In April 1995, a third natural area in Rwanda, Akagera National Park, became threatened when 700,000 cattle and 250,000 Tutsi herders moved 15 to 20 miles into the park (Lorch 1995). Because of a lack of arable land, Rwandans have sought out parks as the last remaining unoccupied territory. Akagera National Park, located on the eastern border of the country, has a wide variety of fragile habitats, from swamps and savannah to forest and hills, harboring

gazelles, Giraffes, African Elephants and Leopards (Lorch 1995). Rwandan authorities did not exclude the herdsmen and their livestock but tried to convince them to cull their herds (Lorch 1995). In southern Rwanda's Nyungwe Forest, the Wildlife Conservation Society's colobus project, which protected groups of hundreds of these monkeys, was also devastated. In February 1995, investigators found that one-fourth of a 120-member colobus group had been killed during the war, many for their long fur, which was used in marriage rituals (Fine 1995). Researchers came upon animal snares and concluded that this national park would no longer be protected as such, but would become a multiple-use forest (Fine 1995).

Uganda's rare wildlife also incurred losses from Rwanda's war and Burundi's civil strife in a ripple effect. An extremely endangered bird of the Virunga Mountains, the Congo Bay Owl (*Phodilus prigoginei*), was recently rediscovered after being thought extinct. Not seen since 1951, it was seen in Uganda's Itombwe forest in mid-1996 by scientists from the Wildlife Conservation Society. A type of barn owl, the Bay Owl was previously known only from a specimen collected in Zaire's Kivu province in 1951 (BI 2000, Hart 1996). The owl is restricted to a small area of mixed rainforest and savannah near the Rwandan border (BI 2000). Dr. John A. Hart, the zoologist who found the bird, saw farmers clearing the surrounding forest to create new farmland; they had entered the area seeking refuge from the civil wars in neighboring Rwanda and Burundi (Hart 1996). Although the total population of the Bay Owl is not known, it is presumed to be extremely small, and its future survival is uncertain. This area has no protected status and the entire known habitat of the endangered Congo Bay Owl is being degraded by clearing for livestock grazing and farming (BI 2000).

Some of Rwanda's refugees fled to Tanzania as well. More than 535,000 Rwandans traveled south into that country, staying in refugee camps near the border until December 1996, when the Tanzanian government demanded that they return to Rwanda. Former Hutu soldiers, fearing possible imprisonment for war crimes, convinced many refugees to travel east instead, into the heart of Tanzania's Burigi National Reserve. Once there, they stripped vegetation, killed large numbers of animals, began planting crops, and caused an increase in violent crime in local villages (AP 1996). At this point, the Tanzanian army routed them forcibly, and a stream of refugees many miles long was pushed back into Rwanda.

By 2001, a state of anarchy prevailed in the region, with these countries still at war. A United Nations report concluded that business and military leaders from Uganda and Rwanda were looting forests and parks in the Democratic Republic of the Congo for natural resources and meat (Lauria 2001). The New York-based International Rescue Committee reported in May 2001 that an estimated 2.5 million people have died as an indirect result of the previous three years of civil war in the Democratic Republic of the Congo (Salopek 2001). The fighting drove hundreds of thousands of people into the forests, where they lived off the land, dying of rampant disease and malnutrition in the rebel-held jungles (Salopek 2001). Gangs of poachers entered these rainforests, placing snares to capture elephants, Leopards, antelope, wild pigs, and monkeys for the bushmeat, fur and ivory markets in large cities. A camp of these poachers, many of whom come from neighboring countries, was encountered in the travels of Wildlife Conservation Society biologist Michael Fay. Fay and his group, including National Geographic Society filmmakers, came upon a sizeable camp with a very large Leopard skin stretched out on pegs, with hundreds of antelope and monkey bodies being cooked on open fires. Fay was so irate that he burned the entire camp and all the skins (shown on National Geographic Explorer, April 2001, entitled "Extreme Africa"). Although laws ban such killing, no game wardens patrol these forests, which were not part of a national park. Fay's intention in traveling across Central Africa, as described in *National Geographic* (Quammen 2001), was to show the world the great treasure being plundered by loggers and meat hunters before it is too late to save this large rainforest.

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The future of wildlife in Rwanda, the Democratic Republic of the Congo and surrounding countries remains

extremely uncertain. The region is a microcosm of struggles that may soon be commonplace as human populations continue to rise and compete for dwindling land and resources. Markets as far away as Europe and North America buy the timber, minerals and ivory that are being exploited here at the expense of the environment. At the present rates of loss, little wilderness or natural forest will remain anywhere in the world. The damage done to parks and reserves by tree cutting, clearing land, and killing native wildlife, especially for commercial purposes, devastates biodiversity and endangers species reliant on these refuges, which are often their last remaining habitats. The World Conservation Union issued a report in 2001 on the urgent need to protect the world's 17,000 large nature preserves from intrusion by poor farmers, who have nowhere else to go (Revkin 2001). Half of these preserves now have people cutting forests and tilling land in biological hotspots and areas with large numbers of endangered species (Revkin 2001). At least 900 million people earn less than $1 per day, and 630 million live in areas of high biological diversity, according to the report's author, Jeff McNeely (Revkin 2001). Organizations, such as Future Harvest, which co-authored the study, are attempting to help poor farmers by providing means to enrich soil through fertilizers and rotating crops to maintain corridors of undisturbed land as wildlife habitat, and to grow shade crops, such as coffee and cocoa, which maintain forests (Revkin 2001).

John Terborgh (1999), a Duke University scientist, chronicled massive destruction of parks by farmers, logging, livestock and squatters in *Requiem for Nature*. This book paints a gloomy picture of wanton neglect, insufficient funding and failure by governments to protect parks and reserves, many of which harbor endangered species and magnificent landscapes. In Peru, for example, national park officials in the capitol city were not even aware of the existence of the Cerros de Amotape National Park. When Terborgh visited the park, he found it had been logged by the army, and cattle grazed throughout. Yet this dry tropical forest is one of the most important centers for endemic plants and animals in the world (Terborgh 1999). Similar tragedies are occurring in Mexico, where logging trucks leave the spectacular montane Nevado de Colima National Park loaded with giant tree trunks, and cows consume all the new tree saplings from the few remaining old alder trees (Terborgh 1999).

In Colombia's Tayrona National Park, six park officials have been killed by rebels and squatters, drug traffickers, loggers and others, who are destroying it; 20 percent of Colombia's 22.2 million acres of parkland is in the hands of squatters or has been deeded to private interests (Terborgh 1999). Colombia has an extremely rich diversity of tropical birds and mammals, and much of the pressure on its parks is a result of the US market for drugs, which offers poor people a far greater income than they can earn through traditional farming. The Santa Marta region in Colombia's northeast has an extraordinary wealth of birds and other species found nowhere else. The endangered Santa Marta Parakeet (Pyrrhura viridicata); Santa Marta Sabrewing (*Campylopterus phainopeplus*), a hummingbird; and the Santa Marta Bush-tyrant (*Myiotheretes pernix*), a flycatcher, are among these (BI 2000). Conversion of forest to marijuana and coca plantations, compounded by US-sponsored government herbicide spraying programs to kill drug crops threaten these and other species of the area. Spraying contaminates the soil and water, and often the small aircraft destroy natural forest and traditional crops instead of the target drug crops. In March 2001, four governors from Colombian provinces protested the $1 billion US herbicide spraying program, saying it was jeopardizing the health and food supply of farmers (Marquis 2001). They asserted that the defoliation ruined food crops and alienated people from their national government, while not succeeding in curbing the narcotics trade (Marquis 2001). The Santa Marta region has already lost 85 percent of its forest habitat (BI 2000). Rebels have taken over much of the area, clearing forest for drug crops and killing members of native tribes, who have traditionally tried to protect the forest and wildlife.

The Democratic Republic of the Congo is in the early stages of a similar anarchy involving rebels and forest destruction. The late President Mobutu and other high officials acquired immense fortunes by siphoning off the nation's mineral and tax revenues and foreign aid funds. They purchased palaces and estates around the world and lived sumptuous lifestyles. Almost none of the revenue from the rich mineral industry went to public works, with the result that the majority of the country's people are illiterate and poorly fed and housed. Even the streets of the capital city are unpaved and littered with trash. Mobutu's personal fortune is estimated at $3 billion by some, and as much as $10 billion by others (Sachs and Rotberg 1997). This country had been a territory of Belgium, known as the Belgian Congo, prior to its independence in 1960. Over the next three decades, the United States and European nations

supported Mobutu's regime, which became increasingly autocratic and corrupt. Any opposition was quickly suppressed. By the mid-1970s, the country neared financial ruin (French 1997). The United States, the International Monetary Fund and the African Development Bank supported Mobutu's regime until the end of his reign (Rotberg 1997). The funds were spent mainly for military purposes and for Mobutu's personal enrichment.

Strong opposition to his regime came from an opponent, Laurent Kabila, who drove Mobutu from office in 1997 and renamed the country, the fiDemocratic Republic of the Congo.fl Mobutu died September 7, 1997, in Morocco, where he had taken refuge. He left the country $14 billion in debt, a sum almost three times the country's gross national product (Sachs and Rotberg 1997). During the struggle among Mobutu's forces, Rwandans and Kabila™s soldiers in Virunga National Park, four Mountain Gorillas were killed, one silverback and three members of his family. The International Gorilla Conservation Program reported that these Gorillas, who were tame and accustomed to tourists in Virunga National Park, were shot in crossfire when Rwandans entered the park and encountered Kabila's soldiers. Kabila was assassinated in 2000, replaced by his son, who was educated in Tanzania. He has moderated some of his father's extreme programs and appears to want to end the conflicts that are dividing the countries of Central and East Africa.

The new government plans to rebuild 50,000 kilometers (31,000 miles) of roads (Wallis 1998). Loggers supply local hunters with weapons, ammunition and a ready market for the meat of Gorilla, Chimpanzee and other protected and endangered species (Pearce 1995). In a growing trend, more and more Central and West African towns are becoming dependent on bushmeat. A study in the neighboring country of the Congo documented that a single town of 10,000 people consumed nearly 6 tons of wild animals every week (Counsell 1997). In Gabon, some 8 million pounds of bushmeat are sold annually, half in urban areas (Tuxill 1997). Recent research has determined that even selective logging has damaged ecosystems in tropical African rainforests, and hunting has eliminated keystone species, such as forest elephants, that spread the seeds of many forest trees (Counsell 1997). Logging also leads to uncontrolled hunting as roads open up wilderness areas.

The Democratic Republic of the Congo has major reserves of cobalt, copper, cadmium, diamonds, gold, and coltan, an extremely valuable material used in making cell phones and computer games. The mining of these resources has damaged large areas of forest as thousands of people vie for high-paying jobs. The mining is uncontrolled by the government, as deals are brokered between international corporations and rebel leaders or even with foreign governments, such as Rwanda, which controls the $250 million per year coltan trade.

Endangered Pygmy Chimpanzees, or Bonobos (*Pan paniscus*), are endemic to these forests in a relatively small portion of the Democratic Republic of the Congo, and their habitat is being decimated by loggers, who construct a maze of new roads (Kingdon 1997). Remarkably intelligent and peaceful, primatologists consider Bonobos to be unique in behavior and ecology; they represent a profoundly important example of evolution (De Waal 1997). Numbering only about 13,000 animals, they are declining and classified as Endangered by the IUCN. No major reserve has been set aside for them. Another rare animal of the region, the Bongo (*Tragelaphus eurycerus*), a beautiful, striped forest antelope, is listed as Endangered in the eastern part of its range in Kenya, and Near-Threatened in the Democratic Republic of the Congo, as logging operations have surrounded the boundaries of an important reserve for this species (Counsell 1997; Hilton-Taylor 2000).

Wildlife Conservation Society biologist Fay finished his 1,200-mile voyage through many unexplored regions of the Democratic Republic of the Congo and neighboring Gabon in the spring of 2001. He found Chimpanzees and Gorillas that had never seen humans and approached his group with curiosity, and other areas where these great apes were completely absent, perhaps as a result of ebola disease (Quammen 2001). Impenetrable swamps and miles of tangled shrub, giant trees alive with insects, birds and lizards, abundant signs of forest elephants and buffalo, networks of streams and spectacular vistas of vast waterfalls and distant mountains still exist in the region, yet loggers, gold miners, poachers and displaced people are increasing in number, destroying this wilderness bit by bit.

A sign of the future, should logging and bushmeat hunting continue, was a traumatized, orphaned monkey, tethered

on a rope in a hunter's camp. Seen by Fay's group, its photograph appears on the cover of *National Geographic* (March 2001). This young Mandrill (*Mandrillus sphinx*) had perhaps witnessed the slaughter of its entire family and was now in a strange and abusive environment without its fellows. This species is threatened in the wild and listed as Vulnerable by the IUCN. Among the largest of all monkeys, Mandrills weigh up to 54 kilograms and live only in the rainforests of Cameroon, Equatorial Guinea, Gabon and the Democratic Republic of the Congo (Nowak 1999). The adult male has an extremely dramatic appearance, his face spectacularly marked with electric blue ridges beneath his eyes, set off by a bright red stripe that goes down the middle of his nose and covers a large, round nose patch surrounding his nostrils. His face is framed by a mane of grizzled, olive-brown fur. The female is a somewhat smaller and less flamboyant version of the male. These are the only primates that move about on the ground in very large groups, numbering up to 600 animals. They feed on a large variety of plants, roots, fungi, invertebrates and, occasionally vertebrates (Kingdon 1997). Their sole habitat--undisturbed, primary rainforest--is disappearing rapidly. They are intensively hunted in some areas for the male's shaggy mane, which is used for capes and headdresses (Nowak 1999).

Mandrills are also killed for bushmeat, which is their most immediate threat, according to biologist Jonathan Kingdon (1997). Mandrill meat is more highly valued in these markets than beef, and hunters employ dogs, guns, spotlights, deep-freezers and trucks to harvest them, especially in the Democratic Republic of the Congo and Gabon (Kingdon 1997). These magnificent primates may be important seed dispersers, yet research has only begun on their wild ecology. They may vanish from their once vast realm before their role in the African rainforest is understood.

These ecological and political crises were long in the making. Decades ago, international funds such as the World Bank could have developed environmentally friendly industries, such as ecotourism, in Rwanda, Uganda and Zaire, with a large percentage of the profits going to local people. Aid organizations could have funded or encouraged these nations to promote literacy and conservation education and to provide birth control education. Foreign aid to Zaire by the United States and European countries could have gone toward helping the people of that country achieve economic independence, while promoting environmental protection.

Human Tragedy and the Looting of Virunga's Treasures: Page 14

There is worldwide interest and concern for the survival and conservation of the Mountain Gorillas and other wildlife of the Democratic Republic of the Congo, Rwanda and Uganda and an enormous potential market for ecotourism in many parts of these countries that would benefit both the people and the wildlife. Mountain Gorillas have attracted $10 million in tourism revenues to Rwanda (Tuxill 1997). The forests of all three countries, as well as those to the west in Cameroon, the Ivory Coast, the Congo (as distinct from the new Democratic Republic of the Congo), and Gabon harbor many zoological curiosities that could attract tourists, such as enormous Goliath Frogs, largest of all frogs, now threatened from over-collecting and habitat loss. Beautiful Congo Peafowl (*Afropavo congenis*), the only pheasant species in Africa, are endemic to the Democratic Republic of the Congo, resident in the Kahuzi-Biega National Park and several other reserves (BI 2000). Threatened by hunting, these large, crested birds would be a big attraction for bird-watchers. Other unusual wildlife, such as tiny forest antelope less than 2 feet tall, inhabit these rainforests, where towering trees draped in mosses and orchids have crested eagles nesting in their crowns. At the forest floor, blizzards of butterflies drink at streamsides, while colorful lizards flit up tree trunks. One innovative approach to wilderness protection could acquaint people around the world with such natural treasures without their having to travel. It could also help local people with funding. It is the use of videocameras connected to satellites that record wildlife and landscapes for the Internet. Internet users pay small fees to tune into these videocameras and their websites. A large portion of the funds could be given to local people. This popular new technology has helped South African national parks with their expenses. Small cameras can be placed in extremely remote areas and can be operated on solar power. They have virtually no impact on the environment, unlike large numbers of ecotourists.

One method of protecting endangered forests, which play an important role in reducing global warming, is the US Initiative on Joint Implementation, which encourages public utility companies to invest voluntarily in forest conservation. Through the Carbon Sequestration Program, sizeable expanses of tropical forests, which absorb enormous amounts of carbon dioxide, are being protected. Wisconsin Electric Power Company, Detroit Edison, PacifiCorp and Cinergy donated $2.6 million in 1995 for a 15,035-acre forest in Belize, adjacent to the Rio Bravo Conservation and Management Area. American Electric Power in Indiana is cooperating with PacifiCorp and British Petroleum to protect 5 million acres of Bolivian forests from logging (Passell 1997). This approach protects large amounts of forest in a cost effective manner: the estimated cost of sequestering 1 ton of carbon this way is just 37 cents, less than 1 percent of most emissions-reducing technology, according to *The New York Times* (Passell 1997). General Motors has helped purchase 30,000 acres of forest in southeastern Brazil, home of the tiny Golden-lion Tamarin (*Leontopithecus rosalia*). More than 90 percent of this forest, known as the Atlantic Coastal Forest, has been destroyed, and it is one of the world's greatest centers of biodiversity (Mittermier *et al*. 1999). This program should be used in conjunction with reduction of emissions from power plants and vehicles--not as a substitute.

In another cooperative venture to save tropical rainforests, US chocolate makers are urging owners of small farms to grow cacao, a crop that is grown in the shade of large trees (Yoon 1998). A worldwide shortage of chocolate has resulted from the spread of diseases in large-scale cocoa plantations in tropical regions around the world. Such diseases do not spread or take root when crops are grown in smaller, shaded areas which have a natural diversity of plants and animals, including insect-eating birds and reptiles (Yoon 1998). With the world's sweetest tooth, the United States consumes 629,000 tons of chocolate per year, far outstripping its nearest competitor, Germany, where 285,000 tons are eaten annually, according to the International Cocoa Organization. The American Cocoa Research Institute, the Smithsonian Migratory Bird Center and various candy companies, including Mars, Cadbury, Nestle and Hershey, are all cooperating in strategies that promise to conserve tropical trees and wildlife, and grow cacao plants in ecological ways (Yoon 1998). Huge plantations of cacao in Brazil and elsewhere have lost as much as 80 percent of their crop to fungal and other diseases in recent years, diseases that often spread in large plantings of a single crop.

Scientists have long noted that birds are abundant in small forested cacao and organic coffee farms, and they are encouraging this new cooperation to protect tropical birds as well as the hundreds of species of North American and European birds that winter in tropical countries. Shade-grown, organic coffee is also helping to save rainforests. A trend away from traditional shade-grown coffee into new strains that are grown in the sun, has resulted in the clearing of millions of acres of rainforest to grow this coffee for markets such as the United States. To counter this trend, some organic companies, organizations and institutions, such as the Smithsonian, are taking a strong stand urging people to buy shade-grown coffee to protect rainforests and migratory birds from North America that winter in Latin American forests. This coffee is sold in many natural food markets and chains, such as Trader Joe's. The restaurants and coffeehouses, such as Starbucks, that still use sun-grown coffee should be encouraged to sell shade-grown coffee to help preserve forests and wildlife.

Debt-for-nature swaps can provide relief for countries saddled by debt from loans made by the World Bank and other international funds. Through these swaps, a portion of a nation's debt is paid by the donor, which may be a conservation organization or other entity, in exchange for the establishment of parks. These swaps have been undertaken in Madagascar and several other countries. A growing movement to convince donor countries to forgive these debts is being waged by conservation and human rights organizations. Should these debts be erased, much environmental degradation would be avoided, since many destructive programs are carried out solely to pay off debt. One such program, called "Avanca Brasil" or "Advance Brazil," envisions a massive development program in the Amazon Basin, crisscrossing the forest with roads and railroads and damming rivers to produce energy (EII 2001). A minimum of 28 percent of this great forest would be destroyed and, more likely, at least 42 percent (EII 2001). Just since 1995, 5 million acres of Amazon forest have been leveled for development (EII 2001). These forests, a major factor in preventing global warming through absorption of carbon dioxide, produce vast amounts of oxygen and harbor a large percentage of the world's biodiversity.

If no positive steps are taken, these last sizeable rainforests will be gone, and severe climatic and ecological harm will result. The great forests of Central Africa are also in the process of being destroyed. World-class national parks, such as Virunga, may be completely destroyed within a generation by illegal logging, squatters and bushmeat hunting.

Earth's Worth

Governments around the world grant logging or mining contracts on a daily basis. Thousand-year-old forests and wildernesses covering vast areas are bargained away in deals made between corporate representatives and government officials, often through bribery. The fates of the native wildlife and plants of these regions hinge on the type and level of exploitation. Wildlife, plants, and their habitats survive or die out as a result of decisions made by politicians, most of whom have no understanding of the importance of preserving diversity and extensive areas of natural landscape. At the present rate of destruction, wilderness will soon be gone, carved up and exploited for commercial purposes or destroyed by settlers.

Earth's Worth: Page 1

Citizens of the wealthiest countries represent some 20 percent of the world's peoples, but consume 80 percent of the planet's resources. The high standards of living that are enjoyed in North America, Western Europe and Japan depend in large part on importation of low-priced raw materials from poor countries. International corporations have few laws restricting their activities, which are causing major damage to forests, rivers, lakes and other environments. Moreover, the market provided by Europe and North America and, most recently, by some countries in East Asia, encourages fast-paced exploitation. Many of the recent logging contracts signed in Africa, Russia and South America have been negotiated to repay debts incurred from loans from the International Monetary Fund, World Bank or other funds. These loans are often for the construction of dams, factories or mines that primarily benefit third parties, such as large corporations. To repay the loans on schedule, countries are pressured to exploit their natural resources, forests and minerals, which are sold at low prices. Such loans rarely help nations develop according to their avowed intention, but send poor countries into an ever escalating debt that requires more and more forest cutting and other exploitation for short-term gains.

The US government's foreign aid tends to encourage mega-projects that do not help the populations of developing countries. Development that is environmentally friendly, based on small-scale business or ecotourism, is of far greater value in helping people as well as preserving wildlife. The decades that have passed since the publication of E.F. Schumacher's 1973 book, *Small is Beautiful. Economics as if People Mattered*, have only validated the philosophy of helping people through small-scale grassroots programs. Economic development programs that respect both people and the environment by finding means through which people can be economically secure, maintain their culture and live in their ancestral regions without destruction to natural ecosystems, should be the model in the future. The concept of small-scale eco-development has been endorsed by various conservation organizations, and use of solar

cookers, bio-gas and fertilizer from livestock manure, development of crafts and other small-scale industries, education on crop rotation and use of crops adapted to particular areas, preserving forests to prevent erosion and not living in flood plains are examples of this approach. A wide variety of organizations are carrying out such programs in many parts of the world. Such approaches are also needed in North America and Europe, where conservation education has failed to teach such basic principles, and government officials lack basic knowledge about the environment.

Earth's Worth: Page 2

Subsidies provide another disincentive to conservation. On a worldwide basis, governments spend $700 to $900 billion per year on subsidies that actually encourage the destruction of forests and other natural areas (Grossfeld 1997). In the United States, the taxpayer pays for road building in national forests to enable logging companies to enter wilderness areas. The Forest Service charges these companies a fraction of the retail value of these trees--sometimes $10 or less for a giant tree worth $25,000. Yet almost no subsidies or tax benefits are paid for the use of recycled materials, such as paper, that would save the cutting of thousands of trees. For this reason, it is cheaper in the United States and many other countries to cut forests for paper than recycle used paper, and to obtain minerals from mines rather than from recycled metals. To further the lack of logic of this situation, one US government department encourages environmental destruction through taxpayer dollars™ subsidies for logging and mining, while others spend public funds to clean up the pollution and preserve species that become endangered from these activities.

A coalition of 26 organizations compiled information on US subsidies that have negative effects on the environment, entitled "Green Scissors '98." It found that the United States spends $49 billion every five years on subsidies and environmentally destructive programs. The report recommended drastic slashing in these "polluter pork" programs to protect the environment and save taxpayers billions of dollars of misspent money each year. The Institute for Research on Public Expenditure in the Netherlands produced a report in 1997 entitled *Subsidizing Unsustainable Development: Undermining the Earth with Public Funds*. After a lengthy examination of subsidies around the world, which range from inexpensive irrigation water to free land for settlers and mining operations, this study concluded that subsidies are economically counterproductive and disastrous to the environment, resulting in deforestation, overfishing, polluting and other destructive activities (Crossette 1997a). Many species are endangered as a byproduct of these subsidies.

Earth's Worth: Page 3

The gross national product of a country is considered the major yardstick by which economic success is measured, and the natural world is traditionally valued in terms of the revenues it produces when exploited. This rigid and limited evaluation was recently examined and found lacking by a team of 13 ecologists, economists and geographers, who analyzed the monetary value of ecological systems to human society. They sought to place specific values on 17 types of environmental services that 11 ecosystems provide to humans each year (Stevens 1997b). Among these ecosystems were open oceans, estuaries, seagrass and algae beds, coral reefs, tropical and temperate forests, grasslands and rangelands, tidal marshes and mangroves, wetlands, lakes and rivers (Stevens 1997b).

In a report published in the scientific journal *Nature*, these specialists estimated the total global value of these ecosystems and their production at $16 trillion to $54 trillion per year, with $33 trillion the most likely figure; by contrast, the gross national product (all the goods and services produced by the world's peoples each year) was estimated at a mere $18 trillion (Stevens 1997b). They rated the value of nature's climate regulation at $684 billion,

natural raw materials at $721 billion, pollination by natural pollinators at $117 billion, recreation and ecotourism provided by nature at $815 billion, soil retention and formation at $53 billion, water supply at $1.7 trillion, and food production at $1.4 trillion. Thus, ecosystems such as forests, which provide several of these ecological services, such as climate regulation, ecotourism, soil retention and water supply, are worth far more left standing than cut as lumber for short-term profit. Wildlife performs services as well, including natural pollination, attraction of ecotourism and recreation such as bird-watching, and others such as seed dispersal and soil enrichment. The linkages between particular ecosystems and local economies were systematically analyzed in this study; for example, the Louisiana shrimp catch depends on wetlands as nurseries, and these wetlands also provide flood control and other services in their overall value (Stevens 1997b).

If the costs of destroying these ecosystems were computed when development was considered, such as the loss in flood control and water pollution filtration by wetlands, the researchers concluded that society would be more likely to protect them from destruction. They pointed out that when a wetland is filled in for a shopping center, the dollar value of that habitat in preventing floods and cleansing water is not figured in, resulting in a gradual erosion of natural wealth (Stevens 1997b). The heavy rains that ravaged many parts of the world in 1997 and 1998, caused by El Nino's effect on the weather, produced floods and mudslides in areas where forests had been cut and wetlands filled. Hundreds of lives were lost, and property damage totaled billions of dollars. Areas with forest and extensive wetlands were hardly damaged. Some wetlands are being restored in the United States--river courses returned to natural curves, and flood plains protected from building, in the realization that the lost income from not developing these areas is more than compensated for by the protection from natural disaster they provide, which creates economic stability in developed areas located far from wetlands.

However important such economic analyses are in re-evaluating our destruction of ecosystems, preserving nature cannot be reduced to economic calculations. If this is the sole basis of conservation, it could lead to destructive manipulations in the environment designed to accommodate complex economic theories. The major lesson to be learned from these new ways of looking at Earth's use to humans is that we have grossly underestimated life-giving ecosystems and their wild fauna and flora. They have evolved over a period of millions of years, and we must respect and preserve them in as natural a state as possible.

Although people in the United States are far more aware of the ecological value of wetlands and forests, this seems to have had little effect on preserving such valuable ecosystems. Trees are still cleared on steep slopes and other fragile areas, for example. This causes landslides and mudslides and floods, resulting in destruction of homes, roads, farmland and other valuable assets, as well as siltation and pollution of waterways. Yet there is little thought given to banning this practice by law. The World Resources Institute in Washington, DC, has calculated that the loss of value from deforestation is four times as high as the value of the timber extracted, and the depletion of soils, forests and fisheries examined in this study resulted in a 25 to 30 percent reduction in potential economic growth (Stevens 1997b).

A 1997 collection of articles, *Nature's Services: Societal Dependence on Natural Ecosystems* (Island Press), edited by Dr. Gretchen C. Daily, a biologist at Stanford University, concludes that many ecosystems, once destroyed, are either irreplaceable or take thousands of years to replenish, such as ancient aquifers or old-growth forests. Daily concluded that we cannot afford to wait to act until we have disrupted the planet's life-support system beyond repair (Stevens 1997b). Some 20 scientists contributed to this book, including Dr. Norman Myers, author of many books on the value of wild plants to medicine and agriculture. He documented the multibillion-dollar insurance value that wild grains provide in disease resistance (Daily 1997). Katherine Ewel of the Forest Service discussed the lower cost of treating sewage in constructed wetlands, as compared to treatment plants, and Gary Nabhan and Stephen Buchmann found that wild pollinators save American farmers $1.6 billion annually (Daily 1997). This book's experts make a strong case for protecting environments in a natural state and provide evidence that we are only beginning to appreciate the complexity of these ecosystems. This can apply, for example, to commonly accepted mitigation rules used in US wetland-filling cases, in which a wetland is created for one that is destroyed. Ecologists consider that the natural wetland is far more complex and irreplaceable than the man-made one, and they should not be considered

equal under the law.

Earth's Worth: Page 4

In the United States, many politicians and businessmen have opposed environmental and endangered species legislation on the grounds that these laws reduce the profits of commercial ventures. They propose that every developer whose project is blocked by such legislation should receive financial compensation from public funds. These businessmen calculated the value of their financial loss on the appraised value of their land, and added potential profits lost. In 2001, for example, farmers in California sued the Fish and Wildlife Service to compensate for water it lost when a water allotment was diverted for endangered salmon and smelt (Russell 2001). The court ruled in favor of the farmers and ordered the government to pay them the value of the lost water, arguing that the government is constitutionally prohibited from taking property without paying for it (Russell 2001). This ruling could end in negating the effectiveness of habitat protection under the Endangered Species Act for lack of sufficient funding. Ecologically, farmers depriving endangered fish of habitat are impoverishing entire aquatic ecosystems and, in all probability, polluting waters with pesticides and other chemicals in the process. Yet if the value of maintaining the ecosystem in the San Francisco Bay area was calculated in terms of the millions saved in flood damage control, water purification, production of shrimp and other fish, the ecological values would far outweigh short-term commercial losses. If environmental protection laws were written in terms of ecological values, destroying natural ecosystems for the economic benefit of a few would not be allowed.

When the Northern Spotted Owl (*Strix occidentalis caurina*), native to old-growth forests in the Pacific Northwest, was listed as Threatened on the Endangered Species Act and large sections of its habitat protected, it became a focal point, polarizing pro-logging and anti-logging activists. Owl haters urged others to kill these birds, who were blamed for ending the logging industry, with bumper stickers such as "Kill an Owl, Save a Job." Such venom totally obscured the fact that the forests were being overcut and that logging jobs were destined to be cut anyway, as the last old-growth disappeared under the saw. A state in the heart of this owl's range, Oregon, found that decreasing logging ended in helping its economy; an influx of technological businesses provided better salaries than those paid for logging jobs (Egan 1994). The Governor of the state supported the logging restrictions as helping to maintain the overall quality of life in the state, preventing floods and attracting tourists, which are supplying another large segment of the state's revenues. Yet pro-business interests continue to fuel the fires, writing books which conclude that it is easy to understand why a landowner, having an eagle or Spotted Owl nesting, could be tempted to destroy a nest or even kill an endangered animal. Such people maintain that the owner of such land might be expected to destroy it by logging or development prior to designation of Critical Habitat for the species in order to be able to reap profits. The Northern Spotted Owl has, in fact, declined since it was listed on the Endangered Species Act, mainly as a result of Habitat Conservation Plans that have been detrimental to its populations, but also, very likely, illegal killing played a role.

One conservative critic of the Endangered Species Act noted that the Act "has undoubtedly caused the deliberate destruction of millions of other endangered plants and animals" (Jacoby 1998). This explains, according to the critic, why after 25 years, 97 percent of the endangered species list remains endangered (Jacoby 1998). If so many endangered animals are being killed deliberately, enforcement of the Act is urgently needed. Such attitudes are extremely detrimental to the survival of endangered species and should be addressed. Although many animals are being killed, the main reason these species remain endangered is a deteriorating environment and a half-hearted commitment on the part of the US government and the public to saving these threatened species.

A study of America's environmental laws and their effect on the economy was conducted by the nonprofit Institute for Southern Studies, a social policy research group. It concluded: "At the policy level, the choice is really not jobs versus the environment. The states that do the most to protect their natural resources also wind up with the strongest

economies and best jobs" (Smothers 1994).

Earth's Worth: Page 5

Ecotourism and non-destructive recreational uses of nature are among the most valuable of all services nature provides, according to the study mentioned above, and many countries have seen dramatic rises in their revenues from tourism in recent years. In 1995, Botswana earned $100 million from tourism; South Africa reported $6 billion in tourism revenues. Kenya earned $452 million the same year, which paid the wages of 13 percent of its population. One tour company, the Conservation Corporation of Africa, or Conscorp, works out arrangements with local villages in which it promises to build schools and clinics near its lodges, employing many local people in the process. It also buys seeds for farmers to plant vegetables to sell to its lodges and brings villagers from the area into the reserve to educate them about wildlife and ecotourism. Conscorp runs some 22 small--but expensive--lodges in Africa from Kenya to Zanzibar, none of which allows game hunting; its revenues topped $30 million in 1996. Costa Rica, one of the world's primary ecotourist countries, has set aside 25 percent of its land for conservation, and ecotourism draws 1 million visitors per year, who spent some $800 million in the country (CNN special: "What Price Nature?" March 2001). This industry continues to grow at a rate of 20 percent a year, with visitors coming to its cloud forests, tree canopy tours and beaches where sea turtles nest.

In terms of the value of animals, the income from exploitation is dramatically lower than that from ecotourism. African Elephants, for example, when killed for trophies, earn some $4,000 to $20,000 for governments in fees, and the tusks sell for an average of $2,000 apiece. From ecotourism, however, an East African elephant produces an estimated $1 million during its 60 years (Currey and Moore 1994). A 1989 analysis found that the viewing value of tourists who come to Kenya to see elephants is estimated at a minimum of $25 to $30 million per year (Brody 1994). Tourists come from around the world to see these massive animals, and the governments of most African countries place a higher value on live elephants than dead ones. Trophy hunting also kills off the big bull elephants, which are the main breeding animals, as well as large matriarchs, who play a crucial role in guiding and protecting herds. These are the very elephants tourists come to see.

Endangered species in the United States also draw many tourists who travel long distances to see Whooping Cranes in their wintering marshes in Aransas, Texas**;** Gray Wolves in Yellowstone National Park; and California Condors newly reintroduced near the Grand Canyon.

Whales are extremely valuable in ecotourism. They are becoming major money-earners to the increasing numbers of whale-watching tours worldwide. In 1992, 37 countries conducted whale watching tours, and the United States alone earned $260 million. Since then, whale-watching has grown in popularity. A study by the International Fund for Animal Welfare found that in 1998, revenues from whale-watching exceeded $1 billion, with 9 million people participating in 87 countries and 500 communities. By contrast, a single Minke Whale sells for about $100,000 (Talmadge 2000), a one-time profit from these long-lived animals that is far less than they would produce during their lifetimes. Yet wealthy countries, such as Norway and Japan, are still killing whales, catering to whalers, who form a tiny segment of their populations.

Bird- and wildlife-watching and feeding have become major industries in the United States. A Fish and Wildlife Service survey found that in 1991, Americans who watched, photographed and fed birds and other wildlife spent $18.1 billion (Blom 1997). The spending generated nearly $40 billion in total economic activity and supported 766,999 jobs (Blom 1997). Equipment sales for wildlife appreciation totaled $10.6 billion, followed by $7.5 billion spent on travel-related goods and services, and $1.5 billion on wild bird feed (Blom 1997). A 1996 survey found that while only 3 million people in the United States hunted migratory birds, 25 million Americans were considered avid bird-watchers who would drive a mile or more to observe or photograph birds, and 50 to 60 million people in the

United States watch birds at their feeders.

The Fish and Wildlife Service found in a 1996 survey that wildlife watchers, fishers and hunters spent $100 billion on equipment, travel, and publications. When total economic profits were analyzed by the Fish and Wildlife Service in terms of hunters vs. bird-watchers, the bird-watchers spent some $14 billion on all aspects of bird-watching, while bird hunters spent $1.3 billion. *American Demographics* magazine estimated that an even greater amount, $18 billion, was spent by American birders on their hobby. In economic output, Ducks Unlimited, a hunting organization, estimated that bird hunting generated $3.6 billion, while non-consumptive use of birds earned $15.9 billion.

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Consumptive users of wildlife, such as hunters, make up a small minority of the public, approximately 14 million, or 5 percent, and fewer than 1 percent are trappers, yet these interests control state wildlife departments and heavily influence the Fish and Wildlife Service. The fees from hunting licenses fund the majority of state wildlife departments. These departments manage all wildlife within a state, in spite of the fact that only a small number are hunted or trapped, with the result that habitats are manipulated to benefit hunted animals, such as deer, by encouraging shrub and second-growth forest, while species needing old-growth forest, such as woodpeckers, decline as these forests are cut. Endangered species are conserved by state Natural Heritage Programs, but funding is often miniscule in comparison with the fees from hunting. Funding sources include income tax rebates, vanity license plate revenues and grants from general funds, but generally do not begin to fill the need for habitat acquisition, education and conservation programs and research. Greater funding is needed for these programs, perhaps through a small tax, such as the less than 1 percent sales tax in Missouri for wildlife and conservation programs. It generates more than $100 million annually. A tax for non-game and endangered species would provide major funding for these state programs, which fill an important role not played by federal Endangered Species Act programs.

The recent phenomenon of tropical forest ecotourism has produced other comparisons in revenues of exploitative vs. non-consumptive use of wildlife. Dr. Charles Munn, an ornithologist with the Wildlife Conservation Society is studying macaws in Peru's massive Manu National Park, which is the size of Massachusetts. He estimates that a wild macaw is worth $165,000 a year, based on revenues from the growing number of tourists who come to see these colorful, long-tailed parrots in spectacular flights (Munn 1992). A bird trapper receives only a few dollars for a wild macaw which, if sent to a pet store in Europe, might sell for $1,000. Income from the pet trade goes primarily to a small number of exporters, importers and retailers. It does not protect the habitat of the birds, nor does it pay for population surveys to prevent depletions. Moreover, from capture onward, these wild birds are treated very inhumanely, causing high rates of injury and mortality. The capture of wild birds for the pet trade is banned by the majority of the world's nations, but the few that continue it contribute to depletion of wild bird populations, smuggling, and their inhumane treatment (see Trade chapter).

Under Munn's calculations, the value of each macaw in the wild over the period of its life, which averages about 50 years or more, totals some $8,250,000--an enormous sum. This money flows into local economies of villages and towns near the park, local hotels, taxis, restaurants and other businesses. For many poor areas, such income provides much needed services and raises the standard of living. Tourist money is also spent in cities where visitors arrive, and constitutes a major portion of airlines' revenues. Manu National Park has been declared a Biosphere Reserve in recognition of its importance as a center of biodiversity. Its 7,000 square miles protect a large portion of Peru's tropical rainforest. Manu's ecotourism companies are considered models for sharing revenues with local people and protecting indigenous tribes (Munn 1994). These companies have tours geared toward viewing certain spectacular or endangered species, such as Giant Otters (*Pteroneura brasiliensis*) (Munn 1994).

Earth's Worth: Page 7

Although some abuses of the land have resulted from ecotourism, including large numbers of people who can overwhelm delicate habitats, these situations are rare and can be rectified. Ecotourism helps far more animals and habitats than it hurts and, often in an indirect way. An important byproduct of tourism is the protection it accords animals in the areas visited, especially outside national parks and reserves, where most wildlife is on the decline. The presence of tourists tends to deter poachers, and in a growing number of areas, revenues accrue to local people from tourists™ use of restaurants, gift shops, taxis and other businesses. This encourages residents to cooperate in protecting the wildlife and the environment. This applies as much to African savannahs, as to North America or Europe. The non-profit Eco-Tourism Society, located in North Bennington, Vermont, distributes information on responsible travel that does not result in ecological damage and respects local residents. It recommends that tours share profits with residents.

Many conservation organizations now run ecotours and issue pamphlets, such as the National Audubon Society's guidelines for environmentally responsible travel, which describes dangers to specific habitats, such as coral reefs, and suggests non-intrusive viewing and tours that enhance local conservation. Trade in local wildlife is prohibited. The Wildlife Conservation Society has proposed that a fee from tourists be set aside for a land bank to fund national parks in Central America.

As ecotourism rises in its importance to national economies, whale-watchers, tropical forest visitors, coral reef divers and others will demand pristine environments with diverse wildlife. This will be a strong force in favor of passage of strict environmental laws around the world. Moreover, the value of wilderness increases as more and more tourists seek out undeveloped areas. Governments should no longer consider wilderness as wasteland, but as a precious commodity.

The economical arguments in favor of preserving the natural world are strong, but we should be equally motivated by our affinities for our fellow creatures and the natural world. Our ties with nature are very deep and span millions of years. Modern technology has made us forget the awe with which we once regarded the Earth and has encouraged a false sense of superiority and complacency.

Actions and Attitudes

Biologists, conservationists, government officials and many members of the public are regarding the rise in the number of extinctions and endangered species with great alarm. The United Nations has found that species and habitats are being lost at an "unprecedented rate" (Stevens 1997c). The need for effective action has never been greater. Fortunately, concurrent with the general deterioration of the environment and wildlife populations, programs for the preservation of rare species have mushroomed, along with a new compassion for animals. These programs address the status of a small number of species, and if expanded to include a far greater percentage of threatened species, the extinction rate would decline.

Some conservation efforts to preserve endangered species have had remarkable success, while others have had mixed results. The expenditure of large sums of money to save some endangered species has not automatically resulted in an increase in their numbers. It is a common misconception that endangered species, once accorded legal and habitat protection, will survive and increase in number. Unfortunately, many species have died out in spite of conservation measures on their behalf. Through examination of failed programs, fewer mistakes can be made in the

future.

Actions and Attitudes: Page 1

The Javan Tiger (*Panthera tigris sondaica*), for example, was given legal protection and reserves in the 1920s and 1930s, yet it was poached to extinction. If a single facet of a conservation plan is lacking, faulty or unfunded, this can spell extinction for the animal or plant. A reserve for this Tiger was set aside too late, when it was nearly gone. As Indonesia's most heavily populated island, Java had little forested land left, and by 1972, only four or five Tigers survived (Matthiessen 1997). With a very limited population under constant threat from poachers and big game hunters, these Tigers needed intensive anti-poaching protection and biological surveys, which they never received. Without well-equipped and motivated park rangers, research and surveys, education of local people and the goal of conserving Tigers established as a major priority of the Indonesian government, there was no chance of saving these cats. The last Javan Tiger was seen in 1976 (Matthiessen 1997).

Since the 1970s, Tigers have experienced precipitous declines throughout their remaining Asian range. Killed for their "magical" bones and body parts, which are used for Traditional Medicine as well as for potions that are intended to impart virility and strength, these magnificent cats are snared, trapped, poisoned and shot in devastating numbers, estimated at a minimum of one Tiger per day of the fewer than 5,000 that survive. A Tiger is now worth at least $50,000 in Traditional Medicine, placing a price on the head of every wild Tiger. Many experts are predicting the Tigers™ extinction outside of zoos within a few years. One program, however, has shown success in stemming this decline. In Russia's Far East, strong anti-poaching programs and intensive research and survey projects have halted the decline of the largest subspecies, the magnificent Siberian Tiger. This work has been funded by outside organizations including the Global Survival Network, a Washington, DC, organization, and other groups.

Only about 250 Siberian Tigers survived in the wild in the early 1990s, and with 50 or more being killed by poachers each year, their future seemed dim. The Russian government, in economic chaos, was unable to pay wardens a reasonable salary. Many resorted to illegalities to take advantage of the high value of dead Tigers. The open border with China brought an influx of smugglers and traders offering bribes of $5,000 or more to wardens and poor villagers for killing a Tiger. With the infusion of some $750,000 from conservation organizations since 1993 and help from the US Fish and Wildlife Service, well-armed and well-paid wardens now patrol most of the Siberian Tiger's habitat in modern vehicles. Without this outside funding, which must be continued indefinitely, poaching would have extinguished the remaining wild Siberian Tigers. Biological research on these Tigers is being carried out by the Idaho-based Hornocker Wildlife Institute, along with Russian scientists. These studies have surveyed their populations and obtained the first estimate of their habitat needs which, for males, is at least 450 square miles. One

female Siberian Tiger named Lena, being radio-tracked by these researchers, was killed by poachers. Her four young cubs would have starved to death, but they were located when signals were received from the still-operational radio collar, which had been cut off Lena's body and placed next to the cubs. The terrified and hungry cubs were taken into captivity, and the three survivors were sent to US zoos.

Siberian Tiger poaching is finally decreasing. Russian conservation groups are conducting educational programs for local people and investigating suspected poachers along with Russian government officials (GSN 1997). Recent population surveys indicate an increase in Siberian Tigers, and conservation plans are falling into place (Galster and Eliot 1999). The Tiger's prey of deer and wild boar has been heavily poached, and the plan calls for anti-poaching work to preserve these animals (GSN 1997). Tiger biologists have drawn up a plan for a huge sanctuary in the region, suggesting habitat corridors linking isolated Tiger populations, and proposing an end to clearcutting of forests (GSN 1997). Without urgent protective measures, this magnificent cat will disappear. (See Forests chapter for more on this Tiger and its habitat).

Actions and Attitudes: Page 2

For some endangered animals, CITES has been crucial in preventing their extinction. After a prolonged controversy, the African Elephant was upgraded from Appendix II to Appendix I in 1989, which effectively ended the ivory trade that resulted in the slaughter of these intelligent animals, the toll reaching almost 1 million animals for the 1970s and 1980s. The 1996 *IUCN Red List* classified the species as Endangered for the first time, upgraded from Vulnerable status in the 1994 *IUCN Red List*. This status was maintained in the *2000 IUCN Red List*. The ivory trade reduced these slow-reproducing animals, who have a single calf only once every five years, from 3 to 5 million in the 1930s and 1940s to only 300,000 to 500,000 today (Onishi 2001). The high price of ivory in the 1980s encouraged the poaching of elephants outside parks, and when these were killed off, poachers entered national parks, often armed with machine guns. Almost all the large bulls and most of the older females were killed for their tusks, leaving traumatized teenage elephants without leaders and protectors and orphaned infants who starved to death.

In the majority of African countries where elephants survive, they are zealously protected for their value in tourist revenue and for their ecological value as keystone species. Many officials of these countries have said that they do not want future generations to learn about elephants only through books. Yet several southern African countries--Namibia, Zimbabwe and Botswana--which stockpiled ivory from the 1980s trade and from culls carried out to limit elephants, succeeded in 1997 in convincing delegates at the CITES Conference to allow sale of 65 tons of this ivory to Japan. Japan's sponsorship of much of the costs of the 1997 Conference, which took place in Zimbabwe, paved the way for the decision. The President of Zimbabwe made personal requests to delegates to allow the sale. Although CITES authorities enacted controls on the conditions of the sale of this ivory, it was predicted that the decision would open the door to further killing of elephants and ivory smuggling. This proved correct. African Elephants began to be poached again during the late 1990s in Kenya, the Democratic Republic of the Congo and other countries. An elephant orphanage in Kenya received an unprecedented number of orphaned calves at this time. Their mothers had been killed for their ivory in national parks. Some of this ivory is sold locally, and much is smuggled out of Africa.

A large confiscation of tusks was made in Los Angeles in May 2001; these tusks, many of which were very small and obviously from young elephants, had been smuggled from Nigeria in hollowed-out furniture. This indicates that allowing some sale of ivory opens the door to unrestricted slaughter and smuggling that will place the species in a critical--and perhaps lethal--decline toward extinction. When ivory was allowed to be sold on a quota basis in the 1970s, this "regulated" trade failed completely to prevent unregulated slaughter as the price soared. In many parts of Africa, poachers are killing elephants for a trade that may be resuming. Ivory is openly sold in Cameroon, and in Burkina Faso, a West African country north of Ghana, where only 3,000 to 4,000 elephants remain, ivory traders are

selling carvings and jewelry in the capital city (Onishi 2001). One trader even complained that sales had not recovered as a result of the 1989 ivory ban, with larger carvings taking months to sell because tourists are no longer as interested in buying ivory (Onishi 2001). When asked about the need to conserve these endangered animals, he said that like humans, some die, but the species does not become extinct (Onishi 2001). Few Africans have been taught about how close African Elephants came to extinction as a result of the ivory trade, nor about their key role in spreading the seeds of trees and creating waterholes for wildlife. It is also likely that only a small percentage of Africans are aware of the species' immense intelligence and altruism. If these facts were better known, it is likely that most Africans would want to protect these great animals. They are in imminent danger of disappearing from West Africa.

As they attempt to forage in land that is now being tilled or used as grazing land, Asian and African Elephants are killed and harassed by farmers and villagers outside national parks. Wildlife corridors are being proposed in many parts of the world to ease such problems. As human populations grow, invading the last retreats of wildlife, parks and reserves are becoming islands amid development, agriculture and cities. Without corridors of natural habitat linking these islands, wildlife will decline in diversity and abundance. A new national park in Mozambique will link with South Africa's Kruger National Park and provide a corridor and additional habitat for Kruger's elephant populations. Other international parks in southern Africa have opened or are scheduled. Some conservationists have proposed that these parks form the southern end of a wide corridor north to Kenya. This would be an excellent solution to the declining habitat faced by many large mammals of eastern Africa. In the Western Hemisphere, the Atlantic Biological Corridor Project and the Mesoamerican Biological Corridor seek to protect wide swaths of land between Mexico and Colombia to prevent the extinction of wide-ranging animals, such as Jaguars and Cougars. Along Texas' border with Mexico, most of an extremely biologically rich area has been plowed under, and the Fish and Wildlife Service is trying to purchase the remnants of this once rich habitat to link it with adjacent habitat in Mexico for use by endangered wildlife.

Actions and Attitudes: Page 3

In the American West, Grizzly Bears may someday be able to roam from Yellowstone to Yukon in a project known as Y to Y, an immense corridor that would prevent the present isolation of this species into pockets of fragmented habitat surrounded by hostile cattle ranchers. The Wildlife Conservation Society has initiated a program it calls "Living Landscapes," which involves local people living in areas surrounding parks and reserves. It promotes the conservation of animals that have ranges extending beyond the parks in order to help conserve these species, allowing them to be part of functioning ecosystems. This sometimes involves curtailing their own hunting. White-lipped Peccaries, for example, a type of wild pig, are important seed dispersers of trees in Latin American rainforests and also create open spaces on the forest floor by rooting for food. Yet they are heavily hunted for their meat and pelts. Only through an education program in which the local people themselves understand the effects of their hunting and are permitted to manage the land, can the species and its habitat be protected. This organization is applying such approaches to regional conservation in 50 sites in Latin America, Asia, Africa and North America (WCS 2001).

Actions and Attitudes: Page 4

Another fundamental element to the future survival of wildlife in a world crowded with humans is tolerance and a belief that the Earth must be shared. Public opinion has been crucial in land use and protection of natural habitats and landscapes so that wildlife and plants were allowed to survive, even in parts of the world with overcrowding where land was at a premium. Fewer species are threatened in parts of the world where wildlife is respected and considered part of the landscape. In Africa, wildlife flourished when native peoples were the guardians of the land, prior to the

18th century when Europeans entered as colonial rulers. European rule resulted in overhunting and development of large-scale ranches and farms that were fenced, creating a drastic decline in wildlife.

Native Americans have a less proprietary view of nature than Europeans, and many tribes believe in spiritual connections with trees and animals. They treat nature's assets as gifts, for which they express gratitude. In the intervening centuries since colonization of North America by Europeans who failed to respect nature, views have come full circle for many Americans. Wilderness and nature preservation have become high priorities, based on both scientific discoveries about how ecosystems function and a growing desire by people to appreciate nature. Some scientists believe that connections with nature have been an intrinsic part of human nature for millions of years. Dr. Edward O. Wilson calls this "biophilia," or "love of living things," and cites it as a primary human trait. Such ties to nature have nurtured new conservation zeal to help preserve disappearing wildlife and landscapes.

For some people, however, even the most basic ecological and evolutionary principles are refuted in favor of views that justify exploitation and species' extinctions. They describe conservationists as irrational "tree huggers," and animal lovers as "bunny huggers." Anti-environmentalists have formed organizations in the United States, operating collectively as the fiWise Usefl movement. Many elected government officials share these views, and have voted for legislation that fails to protect endangered species and results in destruction of important wildlife habitat. US Congresswoman Helen Chenoweth, a Republican from Idaho, believes that there should be a public referendum regarding which animals can live and which will be allowed to go extinct (Egan 1996). Chenoweth stated to *The New York Times*: "A species goes out of existence every 20 seconds. Surely a new species must come into existence every 20 seconds. There's no way human beings can regulate that dynamic" (Egan 1996). Humans can, indeed, affect the "dynamic," as they have for millennia, and when species are lost, their loss is our loss. Evolutionary biologists would be dumbfounded at her statement. Although species are passing into extinction at a fast rate, new ones are not evolving every 20 seconds, nor even every 20 years or every 200 years, unless one considers the mutations of viruses and bacteria to be new species. Once the Tiger or Right Whale--or any of Earth's myriad species--becomes extinct, it is gone forever. The film "Jurassic Park," which concerned the recreation of dinosaurs from their DNA, is total fiction. Science has not found a way to clone species from DNA obtained from dead animals because the DNA becomes scrambled after death. Nor are such scientific feats anticipated in the near future.

Actions and Attitudes: Page 5

The basic problem that many people find in protecting endangered species is the question of land ownership and the inconvenience that they fear may result when animal or plant habitat is protected. Congresswoman Chenoweth would find agreement among many people living along the Massachusetts coast, who are unwilling to share the beaches with a tiny endangered bird. This bird has caused storms of controversy between its protectors and recreational beach users. The Piping Plover (*Charadrius melodus*), a shorebird, nests on sandy beaches along Eastern coasts, the Mississippi River and the Great Lakes. It has been crowded out of the majority of its nesting sites by the hordes of people who come to swim, sunbathe and drive off-road vehicles. Beaches have been altered or developed for various commercial purposes as well, including levee construction for flood control. In 1985, the species numbered only a few thousand birds and was listed on the Endangered Species Act as Endangered in the Great Lakes, and as Threatened elsewhere in its range. The numbers of this species along the Atlantic coast, from southern Canada to South Carolina, reached 1,377 birds in 1998, and throughout its range, only about 5,913 birds survive (BI 2000). In Massachusetts, where most beaches are public, local authorities and even federal and state enforcement officers were reticent to enforce the law to protect the nesting plovers. Even when parent birds managed to raise chicks, the chicks were often run over by vehicles when they fell into the deep ruts on the beach made by tire tracks, unable to climb up the six inches of vertical sand or flee an oncoming vehicle in time. Plans in 1989 to fence a portion of the beach in Plymouth to protect the nesting birds met with such anger and public protests from beach-users that they were abandoned. In 1991, only a single chick survived in the state, with few beaches strictly protected. Unleashed dogs

killed some of the chicks, but most were run over by cars and all-terrain vehicles.

On Nantucket island, a Massachusetts Audubon Society warden fenced in the nests of two Piping Plovers in 1994, causing such anger from off-road vehicle drivers that they called the police, who threatened to arrest the warden. Neither the state, which protects the species, nor the Fish and Wildlife Service came to the rescue of the Piping Plovers by supporting the actions of the warden. Vandals ripped down the protective fencing. Endangered Least Terns (*Sterna antillarum*) nesting on the same beach produced 24 chicks that year. In one day, 20 were run over. This finally convinced the local selectmen to close that portion of the beach to off-road vehicles, which allowed all eight Piping Plover chicks to survive. The citizens of Nantucket voted the following year to defeat a selectmen proposal to allow vehicle use on the beach, which would have exempted the area from state law protecting the plovers. In 1995, three pairs of Piping Plovers nested successfully on Nantucket, and state restrictions began going into effect to protect their nests.

In Massachusetts, nests increased from 139 in 1986, to 445 in 1995 (Allen 1996a). In a step backward, the state of Massachusetts eased restrictions on beach vehicles in 1996, giving what conservationists called "plover-squashing permits" (Allen 1996b). The Massachusetts Audubon Society estimated that at least 33 plovers would be legally killed each year under the new regulations. Another loss for Piping Plovers was the firing in September 1997 of the town of Plymouth's Beach Manager, who had spent more than a decade protecting these birds from off-road vehicles. This was done to appease recreational dune buggy users. The ban, which closed part of the beach until mid-August to allow the chicks to survive, was lifted. A civil complaint was filed in US District court in April 1998 to force the town of Plymouth to enforce the Endangered Species Act and protect nesting plovers. The following month, a judge ordered the town to prohibit off-road vehicles on the beach from May 19 through August 31, unless strict measures are enacted to protect the nesting birds.

At least one conflict concerning this endangered bird in 1997 had a happy ending. The Cape Cod town of Barnstable's Fourth of July fireworks were nearly canceled by the Fish and Wildlife Service for fear that they would disturb the nesting plovers. A local businessman offered the use of several barges from which to detonate the fireworks. The barges were towed far from shore, and the fireworks proceeded as scheduled. Conrad Troy, owner of Tucker-Roy Marine Towing and Salvaging, Inc., who had been contacted by the Massachusetts Audubon Society for his help, said; fiIf I was an endangered species, I would hope someone would come help me out. We can keep the piping plovers happy and the kids who want to see the fireworks happy" (Anand 1997).

These controversies are indications of a growing trend in which animals, especially endangered species, are no longer eliminated or killed in the United States without protest when they come into conflict with people. Listing a species on the Endangered Species Act is a major step. It is not an end in itself, however. Listing scarcely helped the plovers in the Plymouth beaches, however, because the law was not enforced when opposed by drivers of off-road vehicles and beach users. Only the combination of publicity, local support for the birds and demand for strict protection have resulted in protection of plover nests and habitat preservation. A large contingent of volunteers now works on behalf of these tiny birds. Such cases provide examples of what is needed to prevent extinctions.

Conflicts over protection of endangered species are sure to increase in the future. Only if the public support is stronger on behalf of wildlife than the influence of those who are indifferent or oppose endangered species protection, can endangered species survive. Public support for the less attractive and charismatic species, such as insects, fish, bats and nondescript plants, will come only through effective conservation education.

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Another highly endangered species that nests on beaches has been the subject of a successful reintroduction

program sponsored by the Fish and Wildlife Service in cooperation with the Mexican government. The Kemp's Ridley (*Lepidochelys kempi*), smallest and rarest of all sea turtles, became endangered from killing for its meat and shell. Killed off by poachers in Texas, where it once nested, a long and difficult program was initiated to return these turtles to Padre Island. Thousands of eggs laid by the last 500 nesting females on the turtles™ only remaining nesting beach along the Caribbean coast of Mexico were taken to Texas for hatching. It is not known how sea turtles learn to return to their natal beaches after spending many years at sea, and all precautions were taken to convince the hatchling turtles that they had been hatched in Texas, not Mexico. The eggs were not even allowed to touch the sand on their Mexican beaches. Between 1978 and 1988, when the program was halted for lack of visible success, a total of 22,000 eggs had been taken to Padre Island, hatched, kept in captivity until they were about a year old and then released to the sea. In 1996, to the delight of conservationists, two female Ridley Turtles that had been released 12 and 14 years previously, returned to lay eggs on Padre Island. They were recognized by a special marking the US Fish and Wildlife Service had made on each shell identifying the year the turtles were hatched. By 1999, 16 nests of returning Ridley Turtles were found by volunteers and members of the recovery team who monitor the beach 24 hours a day during the summer nesting season. This is the first known case of successful reintroduction of sea turtles. Numbers of these turtles have increased to about 9,000 in 2001, but they are still only a fraction of the 40,000 filmed nesting on a Mexican beach on a single day in the 1940s.

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Dramatic rescues of endangered species have become commonplace on the island of Mauritius through the efforts of teams headed by Dr. Carl Jones, a scientist working for the Wildlife Preservation Trust, founded by famed author and conservationist, Gerald Durrell. This island harbors some of the world's most endangered birds, and by the 1970s, conservationists had become resigned to the imminent extinction of several of these endemic birds and other endangered animals. In steep decline, they seemed to be following on the path of the Dodo. Crucial to the success of the efforts to reverse this trend was the agreement signed by the government of Mauritius with four conservation organizations in the 1980s, including the Wildlife Preservation Trust, to cooperate in preserving the island's natural heritage. A conservation program in the 1970s to protect the Mauritian Pink Pigeon (*Columba mayeri*) had failed, and the remaining 33 birds were dying off. Captive-bred birds failed to breed, and wild birds were dying from various causes. Jones arrived on the island in the 1980s and, after years of concerted effort in cooperation with a small staff, brought the wild population from a low of 10 birds to approximately 375 birds in 2000. Pink Pigeons now nest at four sites on Mauritius, and another on Ile aux Aigrettes, an islet off the coast (BI 2000). This spectacular increase was the result of a program in which exotic monkeys, rats, mongooses and feral cats were removed from the roosting and nesting grounds of these beautiful, pale pink birds. Captive-bred birds released to the wild were given food until they were independent, and nests were carefully monitored for predation, falling eggs and other mishaps (BI 2000). The program hopes to increase these pigeons to a population of 500 birds within five years.

The Mauritius Parakeet (*Psittacula eques*), once the most endangered parakeet in the world, became reduced to a total population of only six birds in 1978 (BI 2000). The captive-breeding program set up to preserve them in the 1970s was not successful, and the last wild birds were dying out. Jones and other experts in parrot breeding set up a new captive-breeding program and gave the few wild birds strict protection from the many threats that appeared almost certain to cause their extinction. These included an almost total loss of forest habitat, including old trees with nest holes; a lack of available food; monkeys and rats preying on nestlings; infestations by nest fly larvae; and competition for nest sites with various introduced birds and bees (BI 2000). In spite of these overwhelming odds, these lime green parakeets are making a slow recovery. A forest habitat of 8,000 acres has been made into a national park where exotic species have been excluded and captive breeding is now succeeding. At first, the wild parakeets refused to nest in boxes set out for them and would not try to find other nest sites if their nest tree were destroyed during hurricanes. Fortunately, a few pairs did nest, and habitat improvements were made, such as the planting of fruit trees as a food source. Through these and other efforts, the wild and captive populations rose to between 85 and

90 birds by 1997 (Hoyo *et al*. 1997). Numbers continued to rise, and by 2000, 106 to 126 birds survived (BI 2000). This is one of the world's most impressive conservation stories. The vast majority of birds whose populations have declined so drastically experience genetic impoverishment or become prone to other threats by failing to respond to conservation programs. The recent extinctions of Hawaii's honeycreepers and other native birds are testament to the failure of many 11th-hour programs to conserve critically endangered birds. Although still listed as Critical by BirdLife International (2000) and the IUCN, the Mauritius Parakeet may be reclassified as Endangered, should present trends continue (BI 2000).

A third endangered bird of this island, the Mauritius Kestrel (*Falco punctatus*), a small falcon, numbered only four birds in 1974, coming the closest to extinction of any Mauritian bird. Yet today the species is numerous, having almost completely recovered. Through captive breeding and restocking birds to the wild using methods employed in the United States for Peregrine Falcons, and with the help of the Peregrine Fund, hundreds of captive-bred birds have been released to the wild and fed at release sites until they gradually sought wild prey. By 1995, these kestrels totaled 286 birds (Jones and Hartley 1995). Control measures have been successful in reducing exotic species that preyed on them. The population of Mauritius Kestrels reached 145 to 200 breeding pairs in 2000; the species totals from 500 to 800 individual birds who live in three subpopulations in various parts of the island (BI 2000). Jones has also worked to restore habitats for various endangered lizards that are captive bred at the headquarters of the Jersey Wildlife Preservation Trust. These small, iridescent geckoes had become restricted to out-islets, where they survived because introduced predators were absent. Unfortunately, rabbits were released on Round Island, habitat for several of these endangered reptiles, and they multiplied to pest proportions, leaving almost no natural vegetation. Many of these lizards were captured just in the nick of time, and bred in captivity, as the last of their habitat was being consumed. After removal of the rabbits and replanting of native species, these lizards are now being reintroduced.

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Specimens of a highly endangered fruit bat of the small Mascarene island of Rodrigues, the Rodrigues Flying-fox (*Pteropus rodricensis*), were captured for captive breeding when wild populations became threatened by killing for food by local people. It amazed researchers studying them when a female exhibited mid-wife protective behavior seen only in a few other animals, such as dolphins and elephants. One of the females in the process of a difficult breach birth was aided by the other, who fanned her, cradled her in her wings, and showed her the proper position to cling to the cage bar during the three-hour delivery (McFarling 1994). Wild populations of this species are listed as Critical by the *2000 IUCN Red List*. Other flying foxes that once inhabited these islands are now extinct, and the Rodrigues Flying-fox is the last to survive. Without the emergency rescue of some of these foxes, the altruism and devotion of these animals would probably not have been recognized.

Actions and Attitudes: Page 9

The elimination of introduced animals, from goats, cattle and pigs to cats and exotic plants, has been carried out on many islands and island-like environments around the world to preserve native species on the brink of extinction. The governments of Australia and New Zealand, in particular, have rescued a number of critically endangered species. Lord Howe Island, located off the northeastern coast of Australia, once harbored diverse wildlife. After settlement, and introduction of rats and other exotic species, forest clearance and other threats, numerous extinctions of native animals occurred, and most of its surviving species are endangered. Efforts on the part of the government to return the island to its near-original state, with total protection of the remaining tropical forests, coral reefs and other habitats, is underway. Ecotourism has been developed on the island, but the number of visitors is kept at a level that will not harm the island's endemic fauna and flora. Cats may not be kept by the limited number of residents as pets

because of their threat to native birds, and exotic animals are being eliminated from the wild. The endangered, flightless Lord Howe Rails (*Gallirallus sylvestris*), highly vulnerable to predation by cats and other predators, are now gradually increasing with strict protection. Once found throughout the island, these rails became restricted to mountain areas after they were eliminated by feral pigs, goats, cats, dogs and the introduced Masked Owl (*Tyto novaehollandiae*) elsewhere on the island. Captive breeding has been successful, and after work to eliminate exotic animals, these rails were reintroduced to several of their original habitats at lower elevations (BI 2000). The population numbers about 130 birds, with a potential living space for up to 220 birds (BI 2000).

In some cases, control programs for exotic species on islands are not done humanely. Wire snares and poison have been employed rather than live-catch traps, for example. Humane organizations should be consulted by governments to employ humane methods in ridding islands of non-native animals.

The Black Robin (*Petroica traversi*), a beautiful songbird resident on the Chatham Islands off New Zealand, numbered just five birds in 1980, with only one breeding pair (BI 2000). Rats and cats colonized the island after settlement, and deforestation had destroyed the species' habitat. A tree-planting project in which 120,000 trees were planted on Mangere Island, one of its prime habitats, was undertaken (BI 2000). Supplemental feeding and nest protection from introduced Starlings (*Sturnus vulgarus*) and seabirds, which were preying on them, helped somewhat. Real progress began with the use of an unusual program in which eggs of the Black Robin were placed in the nests of other species to raise them and allow the original female, who became known as "Old Blue" and lived 12 years, to lay more eggs. Birds of a related species, the Tomtit (*Petroica macrocephala*), raised these robins, and chicks were successfully reintroduced to Mangere Island (BI 2000). Such cross-fostering has failed with species such as the Whooping Crane, whose eggs were cross-fostered to Sandhill Cranes, because the chicks when mature, tried to mate with Sandhill Cranes instead of members of their own species, having become imprinted. In this case, the chicks bred with members of their own species, and numbers rose to 259 in 2000 (BI 2000). They were all descended from the original pair of birds. The New Zealand Department of Conservation, which had overseen the breeding program, found through DNA studies that the birds are nearly identical genetically (Hutching 1997). Further studies will attempt to discover immune responses and other signs of inbreeding, but outwardly, these robins are thriving, with a 70 percent survival rate and normal fertility (Hutching 1997). Species with such low genetic variability tend to be extremely vulnerable to extinction, having little ability to adjust to changes in their environment or food supply.

Actions and Attitudes: Page 10

More and more countries are taking a keen interest in the preservation of wildlife, and some have ancient protective traditions. The Asian country of Bhutan has a Buddhist ethic of not harming living things. It is the only Himalayan country to have protected the majority of its forests. Rhododendron species 40 feet tall grow there, and the rivers still flow clear, without erosion and siltation. Species that are rare elsewhere in the region still survive in Bhutan. One of its protected areas, Jigme Dorji National Park, is the size of Switzerland and preserves spectacular mountains and cascading waterfalls. It is part of a Bhutanese government plan to create a nationwide system of reserves to protect the country's natural heritage (Adams 1994). Although erosion and destruction of some of the native fir and rhododendron forests have occurred, Bhutanese people support the government's "go slow" approach to development and its plan to preserve wilderness (Adams 1994). A wintering population of endangered Black-necked Cranes (*Grus nigricollis*) is zealously protected by the Bhutanese who live in the valley where the cranes come each year; they regard the birds as integral to their lives and believe that, without them, their harvests will fail. These people miss the cranes™ calling when the birds migrate in the spring, and say that the valley seems empty and silent without them (Greenway 1997). The Environment Ministry watches over the cranes as well and is extremely strict about issuing permits for activities that might harm them.

New approaches may save some of these threatened tropical areas. Australia's Rainforest Information Center has

created an Internet website which plays rock and roll music; its sponsors pay to preserve the rainforest (EII 2001). The organization is focusing on saving several endangered forests in Ecuador, including Los Cedros Biological Reserve and portions of the Madre Selva (EII 2001). The Natural Resources Defense Council has created a list of BioGems (www.savebiogems.org), the 12 most endangered wildlands in North and Latin America. It publicizes threats, such as proposed dams and logging, to generate thousands of letters and e-mails to governments, loggers, utilities and others. The Macal River Valley in Belize, threatened by a dam project, has been saved through this program. The US Duke Energy International company decided to withdraw from Belize after the torrent of protests (NRDC 2001). Boise Cascade planned a major wood chip mill in Chile, which would have consumed 1,200 acres of endangered temperate rainforest a year, with endangered Alerce trees, the massive South American counterpart to the Sequoia. The forests also sheltered tiny Pudu deer and rare birds. The company announced that it would cancel its plans "as a result of unfavorable market conditions" (NRDC 2001). Conservation International (CI) played an important role in the designation by the South American country of Suriname of much of its vast interior, a pristine rainforest, as a reserve. CI, through its scientific studies, was able to show the country's leaders that, kept intact rather than being logged, this rainforest would prove far more valuable for future generations. This organization has accomplished similar feats in Bolivia and other parts of the world, where it also carries out important biological inventories.

An example of cooperating with local people for conservation of wildlife is the administration of the Mara Reserve of Kenya. This reserve is run by the Maasai people through a council which mandates that tourist funds go directly for social services of the tribe; in turn, the Maasai, who live outside the reserve, allow wildlife to move freely without fencing or harassment that is common elsewhere in Africa where livestock is raised (Gakahu 1994). In this reserve are endangered Cheetahs and Black Rhinos, along with 30 species of ungulates, including large numbers of elephants (Gakahu 1994). Local villages in many parts of Kenya are establishing landowner associations that receive funds from tourism to protect wildlife and benefit local economies (Gakahu 1994).

Actions and Attitudes: Page 11

Teaching people that their local wildlife is important to protect as a source of pride has had excellent results in a program in the Caribbean funded by RARE Center for Tropical Bird Conservation, an organization headquartered at Philadelphia's Academy of Sciences. It has employed innovative education and conservation programs to preserve St. Lucia Parrots or Amazons (*Amazona versicolor*), the forests and other wildlife of the island. Biologist Paul Butler, who began this program, has instilled conservation enthusiasm and pride in the people of the island of St. Lucia for these beautiful and rare parrots. His dynamic program has resulted in the naming of this species as the national bird, as well as education programs so successful that children know its scientific name, habitat and need for protection. They enjoy singing songs about the parrots and dressing up in parrot costumes. The people of St. Lucia now understand that the forest and other wildlife must not be destroyed. Art and essay contests are conducted in schools and towns to publicize this parrot, and St. Lucia Parrots are used as logos for many businesses. Forest cutting has been banned, and a substantial portion of the island has been set aside in reserves. This has resulted in an increase from fewer than 300 to between 350 and 500 birds (BI 2000). The Saint Lucia government is dedicated to protecting the parrots and their habitat, and a new ecotourism industry has sprung up. These programs have meant an end to the rampant smuggling of these beautiful, rare parrots, an activity that had been thought uncontrollable because they could be sold for $20,000 per bird to collectors. Protecting the forest for the parrots also resulted in conserving other threatened wildlife of the island and precious watershed. Another native species, the spectacular Giant Swallowtail butterfly, is illustrated on billboards prominently located near towns with the message, "It's ours . . . take care!!!" (Lipske 1994). This approach to conserving endemic wildlife has been adopted on other Caribbean islands, and Butler trains local conservation officers and teachers to continue the programs elsewhere (Butler 1992, Lipske 1994). A film about these programs, "Caribbean Cool," is described in the Video section, and RARE has published a manual, *Promoting Protection Through Pride*, with advice on how to carry out such programs.

Educating children to respect the environment and conserve endangered species leaves a lasting impression if begun in grade school and continued throughout schooling. Children have an innate sympathy and love for animals, and become enthusiastic conservationists. Education about national laws and native wildlife and plants of the region encourages students to have a lifelong desire to protect them and a sense of guardianship that results in opposition to actions that would harm them. Environmental education is required in about two-thirds of US states, from grade school onward. Some schools require special training in environmental science for all teachers. A few high schools are teaching courses in ecology for college credit. The North American Association for Environmental Education has issued detailed guidelines for educators to assess textbooks and other materials for fairness and accuracy, and review by experts (Cushman 1997).

Some conservation organizations have been formed by scientists, such as the highly effective International Crane Foundation and Bat Conservation International. Entertainers have also become involved in conservation. The rock music star Sting, for example, became concerned about the destruction of rainforests and founded the Rainforest Foundation, an organization to raise money to purchase or protect thousands of acres of this endangered habitat, while at the same time informing young people about the importance of these forests to the world. Students and concerned individuals have also founded organizations to protect individual species or particular environments, such as prairies or wetlands. These organizations have raised millions of dollars for rainforest protection and helped many endangered animals.

A number of effective conservation programs began as grassroots organizations established by an individual or a small group of people who wanted to protect a species. Individuals have educated, lobbied and helped raise funds for the purchase of habitat, making extremely important contributions to the preservation of threatened species. The beautiful bluebirds of North America were in steep decline until Lawrence Zeleny began his nesting box program. He popularized and distributed nesting boxes for bluebirds with an entry hole just a fraction of an inch too small for the aggressive European Starlings to enter. The latter birds are taking over the tree nest holes of all three species of North American bluebirds. Starlings are also a threat to several native species of woodpeckers. Through the nest box program promoted by Girl and Boy Scout troops and other organizations, these colorful birds have increased and may again be abundant, familiar residents of orchards, woodland edges and grasslands. Such citizen projects keep species in decline from reaching endangered status. Once endangered, a species' genetic diversity is threatened, and multi-million-dollar state and federal rescue programs, which are not always successful, must be set up to help them.

Only a small percentage of endangered species have such programs in place to aid their populations and protect their habitat, and individuals can make important contributions by volunteering for organizations working to preserve species and their habitats or by founding an ad hoc group. The majority of species listed on the *2000 IUCN Red List* or on Natural Heritage would be far more likely to avoid extinction if conservation programs were created for them, with help from both individuals and organizations. The species most in need are invertebrates and plants, which form the majority of all endangered species and receive the least funding. Within each region or county, little-known endangered species may be fading out without the aid of any organization or individual. Organizations such as The Nature Conservancy, Conservation International, scientists with the IUCN or state Natural Heritage programs provide highly specific information on threatened species in various parts of the world.

Restoration of original ecosystems will become more and more important as natural landscapes decline. The Nature Conservancy, which has purchased millions of acres of land to preserve resident endangered plants and animals, reintroduced the American Bison to its 30,000-acre tallgrass prairie in Oklahoma, and is reintroducing native flowers, plants and animals to restore at least a portion of this magnificent ecosystem. After decades of failed bills proposed in Congress, legislation was finally enacted in 1996 establishing the nation's first tallgrass prairie park of more than 10,000 acres in Kansas. Individuals can also contribute to restoration of ecosystems. Books, such as *Noah's Garden. Restoring the Ecology of Our Own Back Yards*, by Sara Stein (1993), and many magazine articles have called attention to the effects of suburbanization, and the poisoning of native wildlife with pesticides and herbicides used on lawns. They suggest means of bringing back natural ecosystems.

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However effective private organizations are, they cannot begin to have the effect of preserving habitat that governments have. As the owner of millions of acres of parks and reserves, the US government plays a major role in habitat and species preservation. The Land and Water Conservation Fund was established in 1964 to purchase and preserve federal lands, with money coming from oil and gas leases on the coasts. Each year, some $900 million is deposited in this fund, and more than 5 million acres have been preserved in many threatened environments. In 1998, $699 million was approved for spending on land purchases, including $250 million for acquiring the ancient Headwaters Redwood Forest in California to save it from planned logging, as well as $65 million for the New World Mine site near Yellowstone National Park to save it from a huge Canadian gold mine.

National Wildlife Refuges are vital habitat for thousands of threatened and declining species and were first set aside during the Theodore Roosevelt Administration to protect endangered sea birds being killed for their plumes. Now refuges and preserves are key to the survival of Red Wolves, Bald Eagles, Whooping Cranes, Florida Panthers and numerous rare plants, butterflies and other wildlife. In many of these refuges, oil drilling and other exploitation occurs, causing damage to ecosystems and threatened wildlife. The protection these refuges receive is far less stringent than that of national parks and monuments. In some refuges, high-speed roads cut through the middle of marshes where an array of rails, turtles and wetland species end up run over by vehicles. In the largest refuge, the Arctic National Wildlife Refuge, most of the land is open to oil drilling, where water and air pollution have been severe problems. The calving ground of a herd of some 100,000 Caribou within the refuge has been proposed for oil drilling, in spite of the opposition of the majority of the US public. With greater support from the public, laws governing these refuges and their funding might be strengthened to better preserve wildlife.

Some imaginative solutions to the funding problem have been developed. A number of organizations have adoption programs for wild animals. Northern Right and Humpback Whales, for example, identified individually by their markings by scientists studying them, can be sponsored by members of the public, who are then informed of news about their adopted animal. The funds are applied to research and conservation of the species. Grizzly Bears, Tigers, Gray Wolves and other animals may be adopted through a growing number of organizations. Earthwatch, in Watertown, Massachusetts, sponsors thousands of research expeditions by scientists, many of them studying endangered species, through funds from volunteers who pay for the privilege of accompanying the scientists and helping in the research. Endangered species of Brazil's Atlantic Forest, Florida Manatees, rare butterflies and coral reefs are among the many projects Earthwatch helps fund. This organization also awards hundreds of scholarships to students, and teachers who participate can turn the experience into a study program for their students.

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A great blossoming in natural history information has erupted in recent years. Internet websites, accessible to all, have been dedicated to endangered species research programs, biological studies, organizations devoted to helping animals and data compilations. The Internet sets up communications between people around the world, in which education, advice, and even funding help for threatened species and ecosystems can be arranged. Critical situations threatening species can be publicized immediately around the world. On the Internet, students and the public can follow the movements of individual sea turtles, great whales and many other animals equipped with radio transmitters sending signals to satellites. Libraries can be accessed, and websites set up by state, federal and private entities provide highly specific information on endangered species and the environment. Experts may be consulted through these sites. In a recent case, a man in Lebanon came upon an injured eagle with a gunshot wound; he took the bird

home and logged on to the National Geographic Society's website (see Teachers™ Aids in the Appendix for lists of websites) to find Joe Blanton's "Glad You Asked" column. Blanton put him in touch with the Wildlife Center of Virginia, whose staff at its state-of-the-art animal hospital gave him advice on care for the eagle. The man reported that the bird recovered and was released (reported in *National Geographic* June 1997). The possibilities of educating and dispensing information around the world are enormous, and with imagination, many of the problems discussed above might be solved through the free interchange of ideas of people on the Internet.

The Internet is only one new tool for conservationists. Laser discs can combine films and books and be interactive in teaching about subjects such as endangered Chimpanzees. CD-ROMs, although not yet available for many endangered species, contain--on one disc--still photos, films and printed information about a species; heretofore one might have to visit many libraries, rent or buy films by mail and spend many hours to obtain such information sources.

Books, television programs and films about the natural world have opened new doors to the public in the past decade. Natural history films, in particular, are another major influence on education and even public policy. They present views of true wilderness, natural wildlife behavior and conservation lessons. They may have had a significant influence on convincing the public of the need to pass such laws as the Endangered Species Act. Films of the slaughter of spotted cats, American Alligator, and the plight of declining species around the world aroused many people to write their Representatives and Senators in support of legislation to prevent species from becoming extinct.

Films of truly wild places may have played a role in the growth in bird watching and ecotourism, and probably in the changes that have taken place in zoos, with barred cages giving way to more natural exhibits. Having seen films of these animals in the wild, the public was no longer content to see them in such unnatural conditions, behaving so abnormally. Situations once commonplace, such as a pacing Tiger in a barred cage, a single elephant in a dusty, small enclosure, rocking back and forth, now result in protests that have changed zoo exhibits and animal treatment for the better.

The crucial steps that must be taken in the future involve the dissemination of knowledge and concern about endangered species to the general public, who are poorly informed about the enormity and possible effects on their lives of issues such as overpopulation and disappearing species. Although public awareness has increased about environmental decay and the effect that humans have in causing species' extinctions and endangering them, most people still tend to act as if nature will bounce back and will continue to function normally, no matter how extreme the damage. This is a naive point of view. Scientists have not defined the threshold beyond which total ecological collapse will occur in any given area. Also unknown is the number of species that can be extinguished before biological systems become dysfunctional (Leakey and Lewin 1995).

Newspapers, television and other media should be encouraged to publicize these issues further, rather than catering to what they might consider the public's interest. As an example, US network television and newspapers have pointedly ignored human overpopulation and loss of biodiversity, while doing numerous stories on artificial means of having children, such as test tube babies and multiple births. On the positive side, new cable television channels in the United States, such as Animal Planet and BBC, add to the growing number of wildlife and environmental programs on PBS and the Discovery Channel. Unfortunately, these channels presently reach only a fraction of the audience of network television, preventing a better understanding by the public of the problems facing the world. The numbers of films being made and books written on endangered species and the environment have increased exponentially in the past decade, an indication of a growing enthusiasm for the natural world. Other indications of this trend are the rise in memberships in conservation and humane organizations, ecotourism, bird-watching, hiking and visits to national parks and preserves. If these concerns were better translated to activism and altering lifestyles to prevent harming the environment and wildlife, impending mass extinctions might be avoided.

Biodiversity Preservation

Preventing loss of diversity through the growing number and rate of extinctions is extremely important for the ecological stability of the planet. Unfortunately, it is not recognized as a key issue by the majority of people, nor by world leaders. The extraordinary wealth of plants and animals that are in the process of disappearing may represent between 5 and 30 million species, of which only about 1.3 million have been named (Wilson 1993). Insects alone may number more than 5 million species, with the majority of species living in tropical rainforests (Wilson 1993). These animals are key to the Earth's ecosystems, pollinating, fertilizing and aerating soil, and providing food for thousands of animals. Some 751,000 animal species have been identified, far more than the 248,428 plant species, yet these represent only about 15 percent of all living species, in the view of Dr. Edward O. Wilson in his classic 1993 book, *Biodiversity*. Each year, thousands of new species of insects and other invertebrates, hundreds of frogs and, surprisingly, primates, antelope and birds are discovered by science, often in disappearing habitats.

Worldwide, biological inventories, essential to the process of protecting biologically rich areas, receive inadequate funding. Wilson has estimated that more money is spent in New York City's bars in two weeks than studying biodiversity around the world each year (Farnsworth 1994). Some $57 billion is spent on drugs by Americans annually, according to the White House Office of National Drug Control Policy, while less than $1 billion are spent on inventories and biological studies, by some estimates. The lack of funding for biological surveys means that entire ecosystems are vanishing before they are even studied.

Just as many species are disappearing from neglect or uncaring development, scientists are finding and naming hundreds of new life forms, primarily through research programs of private universities and organizations. Ecosystems thought sterile, such as deep ocean environments, are now known to contain significant species diversity. Each descent of a submersible vehicle into these environments brings new discoveries, from beautiful, bioluminescent jellyfish many feet long to bizarre creatures that seem to have emerged from science fiction tales. Many of these newly described species represent previously unknown families, classes, and even phyla of animals.

Some deep sea creatures inhabit the boiling hot water emitted from cracks in the ocean floor, managing to survive what would be toxic to 99 percent of the world's animals. This environment may be similar to the one in which life itself was formed billions of years ago. These areas should be given high priority for government research funding. Studies about Earth™s diversity should not be sacrificed in US federal spending projects such as NASA probes into the possible presence of microbial life on Mars. The discovery of the Mars fifossilfl was given enormous publicity, and in early 1998, chemical studies proved that these supposed evidences of life were actually terrestrial contamination (Wilford 1998). This has not stopped the NASA program from searching for evidence of life on Mars. Tropical forests also represent frontiers to biologists in urgent need of research funding, with millions of species of birds, mammals, insects and other life forms yet undiscovered. They are proof of the importance and urgency of preventing extinctions and degradation of natural ecosystems.

Diversity is threatened by economic concerns that affect every country. Economists tend to consider revenue important--but not such intangibles as biological diversity. Yet history shows that cultures that protect their environment endure far longer than those that do not. Clive Ponting (1991), in *A Green History of the Earth*, makes this point clearly, citing the great civilizations of the past which died out after abusing the land by disrupting water supplies through deforestation, and causing imbalances in ecosystems that resulted in their decline.

Common sense about environment protection and a concern for future generations have inspired many countries and cultures to preserve biodiversity. Those cultures which have a strong bond with nature, especially a spiritual one, are the most likely to protect their environments and wildlife, even when they are impoverished and would profit from

exploiting it. With such people, economic arguments to protect nature are unnecessary, but for the vast majority of people today, short-term profits from nature are justifiable if an urgent economic need exists. In general, harm to the environment and biodiversity may be increasingly unacceptable, however. Polls taken in 2001 in the United States found strong support for environmental protection, with 58 percent of respondents believing that protecting plants and animals should take priority over preserving personal property rights, and nine in 10 saying that it is important for wilderness and open spaces to be preserved (Barabak 2001). Even when government leaders fail to act decisively to protect nature, these actions do not necessarily reflect the will of the majority.

A new activism on the part of the public and native peoples is resulting in many protections for wildlife and the environment. It is also resulting in new alignments of organizations and groups of people. Environmentalists and labor groups have united in opposing the anti-environmental aspects of the World Trade Organization, which caused member countries to reexamine their automatic endorsement of all trade to the exclusion of the environment, wildlife and job protection. Native tribes in British Columbia and conservation organizations united to publicize the impending destruction of thousand-year-old forests along the coast, home to the white "spirit bear." This coalition succeeded in 2001 in stopping logging and achieving permanent protection for some 1.5 million acres (NRDC 2001).

One proposed means of preserving wild animals and plants and their environments is the Convention on Biological Diversity, signed by more than 150 countries after it was presented at the 1992 Earth Summit held in Rio de Janeiro, Brazil. It went into effect in December 1993, after the 30th country, Mongolia, ratified it. It had been signed by 161 nations. Its purpose is to prevent extinctions and biological impoverishment, and it commits nations that ratify it to take actions to preserve species and ecosystems in the process of development.

The Convention requires nations to integrate conservation into economic and social policy to: promote the protection of entire ecosystems, set up protected areas, undertake biological inventories, preserve species throughout the country and restore degraded ecosystems. Many of the wealthy industrialized nations that do not support the Convention succeeded in having weakening clauses written into it, such as "as far as possible" and "as appropriate" (Stevens 1992). It states that nations have the "sovereign right to exploit their own resources pursuant to their own environmental policies.fl Even with its weaknesses, it remains the only international convention to have ever addressed the importance of preserving biological diversity, and as such, it sets a major precedent.

The success of the Convention on Biological Diversity will depend on how strictly it is interpreted. One clause places economic and social development, and the eradication of poverty, as the first priorities of developing countries. This could become an excuse to allow extinctions for the sake of "progress." For example, dam construction or forest clearance could be projects to alleviate poverty, but they would probably cause extinctions. The treaty also states that conservation efforts on the part of developing nations will depend on the flow of money from rich nations, although it recommends that the rich countries benefiting economically from exploitation of resources, such as pharmaceuticals, in poorer countries, should share these profits with the latter (Stevens 1992). It is this latter clause that many members of the US Congress opposed because US pharmaceutical companies did not wish to pay nations harboring medicinal plants. This is a major reason why the United States has not ratified the Convention.

To fund the programs of the Convention on Biological Diversity in developing countries, the Global Environmental Facility (GEF) has been set up, administered jointly by the United Nations Development Program (UNDP), the United Nations Environment Program (UNEP) and the World Bank. GEF raised some $2 billion from wealthy countries, and its administration has been criticized by both donor nations, which want it run in a similar manner to the World Bank, and many developing countries and environmentalists, who accuse it of "green washing" destructive environmental programs endorsed by the World Bank (Lewis 1994). The World Bank has been a major proponent of commercial logging in the last tropical rainforests of Central and West Africa, with disastrous consequences for both wildlife and native peoples.

This Convention is heavily influenced by rich donor countries, such as Japan, Canada, Norway and other European nations. Without strong opposition to the traditional approach of the World Bank in funding large dams, logging and

other such projects, the Convention will not fulfill its more positive potentials to conserve the Earth's biological heritage. Its success will depend on the strong participation of those truly interested in the preservation of nature and willing to encourage countries in this task.

At the end of the 20th century, a poll of biologists was taken, asking them what they considered the greatest threat facing the Earth today. By a wide margin, they chose the loss of biodiversity. The greatest challenge in the 21st century will be to inspire people to want to protect biological diversity, as some nations are doing. Costa Rica, for example, is engaged in a biodiversity program that will catalog virtually every resident animal and plant over the next decades and protect critical habitat areas. The United States, through the Natural Heritage Programs and hundreds of biologists whose work is compiled by the Association for Biodiversity Information, is making progress in its appraisal of the nation's biodiversity and conservation needs (Stein *et al*. 2000). Thousands of individuals are also playing a role by preserving or reintroducing native species into their local areas. In spite of great pressure to exploit the last rainforests and other fragile environments throughout the world, successes in preserving the immense treasure-trove of species that exists on Earth may be turning the tide.

Our lives depend on the proper functioning of the Earth's systems for processes such as photosynthesis, balance of oxygen and carbon, pollination of flowering plants and enrichment of the soil by organic materials. These systems require a large variety of species to function normally, and we are only beginning to understand the role of various organisms and which species are key to each ecosystem. It is not possible to say, therefore, that any species can become extinct without affecting vital life processes. By choosing which species shall survive and which are dispensable, based on economic considerations, as proposed by many politicians, is sheer folly. Irreparable damage may result from such attitudes, yet they are accepted by many governments of the world.

We are presently witnessing the breakdown of many ecosystems. Marine food chains are being destroyed by overfishing and pollution, interfering with the food supply for millions of people. Yet it seems that few of these ecological catastrophes were predicted when fishery or pollution limits were set. Likewise, wetlands are losing wading birds, frogs and fish--all natural insect controls--resulting in increases in insect-borne diseases such as malaria. Predator-prey relations are key to the health of forests and grasslands, preventing overgrazing by prey species that have lost their predators. Yet most wild cats and wolves are in decline, some close to extinction, allowing imbalances to occur. In a growing number of regions, large predators are either absent or so rare that they no longer perform their ecological role. In Yellowstone National Park, for example, the eradication of the Gray Wolf resulted in overpopulation of Elk, which over-browsed aspen and other plants that were habitat to a number of birds and other animals, resulting in their disappearance. Only with the reintroduction of wolves is the ecosystem returning to normal. The overpopulation of deer in the United States and their effect on preventing natural forest regeneration and destroying wildlife habitat is directly related to the extermination of their natural predators, wolves and Mountain Lions. In other cases, prey species, such as deer, antelope and other ungulates, are in steep decline, having been killed off by meat hunters or crowded out by livestock. These species often play important roles in dispersing seeds, as do bats, birds and rodents. One-fourth of all mammals, and one in 10 birds are imperiled. Among these are pollinators, seed dispersers, insect-eaters and prey for other species. The loss of this biodiversity is reaching such levels that it is not surprising so many ecosystems are imbalanced. It is even more alarming to contemplate that the majority of the world's reptiles, amphibians, marine fish and most invertebrates have not even been assessed by biologists.

Species' declines begin with local extinctions as they disappear from portions of their ranges. At this stage, their absence may be affecting ecological communities, but they will not be listed by the IUCN or any other listing authority until the species as a whole becomes threatened. The Gray Wolf disappeared from 90 percent of its US range before it was listed on the Endangered Species Act, by which time major ecological damage had already been done. Species receive protection, endangered listing and conservation attention at the latter stages of declines. The smaller the original range, the faster that species slides to extinction. Ecological effects can occur gradually and imperceptibly in some cases and, in others, quickly and dramatically. Most of the 34,000 plants listed by the IUCN as Threatened occupy restricted ranges and may have undergone slow declines as their pollinators and seed dispersers disappeared, or rapid declines if they were logged or their habitats destroyed. As the concept of saving ecosystems

and their myriad plants and animals gains acceptance, the importance of preserving all the strands of this complex tapestry becomes clear. The tens of thousands of animals and plants listed by the *2000 IUCN Red List* are an indication of a crisis situation, of nature going awry.

Astronauts orbiting the Earth have been overwhelmed by the beauty and fragility of the planet and its uniqueness in the universe. They have described environmental destruction visible from space. Shuttle astronaut Jay Apt (1996) spoke of seeing hundreds of pinpoints of bright lights at night that turned out to be fires emanating from forests in Africa, Madagascar and Borneo. A distant perspective enhances appreciation and desire to conserve our remarkable home. Instead of considering ourselves as separate from the environment, biologist Dr. Thomas E. Lovejoy has suggested, "We must behave as if we live *within* ecosystems, rather than perceiving nature as something confined to a few protected areas isolated within a degraded, human-dominated landscape" (Laurance and Bierregaard 1997).

Scientific study of Earth's diversity and ecology is in its early stages, and an exciting frontier awaits scientists in the ocean, tropical forests and other environments. Yet we are treating this precious living tapestry without the respect it deserves, and the unraveling of these intricate and delicate ecosystems will threaten our very existence.

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Vanishing Species

http://www.endangeredspecieshandbook.org/vanishing_what.php

The Unraveling Tapestry

Now that prairies are plowed under and deserts are filled with subdivisions, the net effect of this recent massive habitat destruction and wildlife slaughter is being assessed. An incomplete tally in the United States, including Hawaii, totals at least 99 species of animals and 240 plants presumed extinct during the past 400 years (Stein *et al*. 2000). This high rate of extinctions reflects the losses of species and ecosystems described in Chapter 1, as well as

those of Hawaii. The Nature Conservancy, which established Natural Heritage Programs in every state to monitor native species, has compiled this and related data to alert the public of the urgent need to preserve the country's natural heritage (Stein and Flack 1997; Stein *et al*. 2000). Its examination of the status of 20,439 US plants and animals found 7,817 species (38 percent) to be either vulnerable, imperiled or critically imperiled (Stein *et al*. 2000). These conclusions were published in a book co-authored with the Association for Biodiversity Information, entitled *Precious Heritage: The Status of Biodiversity in the United States* (Stein *et al.* 2000). This book also illustrates many of these beautiful plants and animals and threatened ecosystems. It found more species in danger than the *2000 IUCN Red List* due to slightly different categories, such as imperiled and critically imperiled, rather than critical and endangered, used in IUCN lists. The latter organization also defines threatened species in terms of the rate of their decline, rather than their actual status.

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Precious Heritage found endemic species, defined as those restricted to the bounds of the United States, and breeding endemics, or those breeding only in the United States, were even more threatened than those with wide distributions. Of the 875 endemic vertebrates in the lower 48 states, almost half (47 percent) are of conservation concern, compared to only 24 percent of all US vertebrate species (Stein *et al*. 2000). 90 percent of Hawaii™s endemics are imperiled in this study. Freshwater species such as mussels, crayfish, beetles and dragonflies are also in steep decline (Stein *et al.* 2000). More than 5,090 plants (33 percent of all native species) are threatened.

Other studies are examining natural ecosystems in the country. The National Biological Service of the US Department of the Interior reported in 1995 that during the 20th century alone, half the natural ecosystems of the lower 48 states became degraded to the point of endangerment (Stevens 1995). More than 1,700 biologists participated in this study, part of a massive biological survey of America's plants and animals (Stevens 1995). Along with the loss of the tall grass prairies and oak savannahs, more than 60 million acres of longleaf pine forests in the Southeast have been cut, and much of this land has been planted with tree farms, creating biologically sterile regions. Northeastern old-growth hardwood forests, likewise, are critically endangered, and survive only in scattered remnants (Stevens 1995). Grasslands in Long Island, the Northeast and California are threatened ecosystems, as are coastal prairies in Louisiana and sedge meadows in Wisconsin. Streams in the Mississippi plain have been greatly damaged as well (Stevens 1995). Fifty-eight natural communities have declined by 85 to 98 percent, and 38 others have declined by 70 to 84 percent (Stevens 1995). The National Biological Service has identified 126 endangered species through this study. Each imperiled ecosystem is home to many threatened species, a reflection of their loss of habitat. This study underlined the importance of preserving large areas instead of small tracts of land, although the latter may be the only way to protect some highly endangered species, such as plants that have become greatly restricted in range.

A 1997 study by the joint United States and Canadian branches of the World Wildlife Fund (WWF), "A Conservation Assessment of the Terrestrial Ecoregions of North America," appraised the ecoregions of the continent including Hawaii (Luoma 1997). Ecoregions are areas defined by major habitat types and, unlike ecosystems, are confined to particular areas. Eastern old-growth forests, for example, are ecosystems scattered over a great area amongst other ecosystems, while southeastern conifer forests constitute an ecoregion. This study found 13 of the continent's 116 ecoregions to be imperiled "hot spots," harboring enormous biological diversity (Luoma 1997). These include Florida's pine scrub, the conifer forests of the Southeast, Appalachia's mixed mesophytic forests, the tallgrass prairie and California coastal sage and chaparral (Luoma 1997). These findings were echoed in the world survey of threatened areas with great biological diversity, *Hotspots*, sponsored by Conservation International (Mittermeier *et al*. 1999). The latter book is illustrated with spectacular color photographs of many disappearing landscapes and species of endangered hotspots, such as the California coastal region.

An inventory of rare, endangered and extinct North American plants and animals, being compiled by the National Biological Service, has verified that the impoverishment of America's natural ecosystems has affected not just isolated species, but entire communities of species. It predicts a steady increase in the number of threatened species because of continued destruction of natural habitats. Habitat loss is the greatest threat to US wildlife and plants, but trade, persecution and pollution play roles as well. Agriculture was ranked as the primary threat to native US species by The

Nature Conservancy study, threatening about 45 percent of plants and animals, while development of land followed, threatening about 34 percent; water projects were the next major threat, and livestock grazing, pollutants, road building, logging and mining had important, but lesser, effects on species and ecosystems (Stein *et al*. 2000).

Threatened species tend to be located in certain "hot spots" in the United States. The one with the largest number of species is Hawaii, with 5,000 populations of species considered imperiled by The Nature Conservancy (Stein *et al*. 2000). In the continental United States, a preponderance of threatened species occurs in the Florida Panhandle, central Florida and the Florida Keys, the Appalachian Mountains, the Cumberlands and Southern Ridge, Cape Cod and Martha's Vineyard, southern California, the Pacific Northwest and southeastern Alaska, as mapped in *Precious Heritage. The Status of Biodiversity in the United States* (Stein *et al*. 2000; page 166). The Cumberlands and Southern Ridge and Valley of northern Alabama and southeastern Tennessee have the country's largest number of imperiled species--186--mainly as a result of the mussels, crayfish and freshwater snails of this region. The Central Appalachian Forest to the northeast has 154 threatened species, with a high percentage of aquatic species as well, including many rare salamanders and woodland plants. The Great Basin Desert of Utah and neighboring states is another species-rich area, with 113 threatened species, while the California South Coast sagebrush ecosystem has 138 threatened species found nowhere else on Earth (Stein *et al*. 2000). (See Grasslands, Shrublands and Deserts chapter).

The list of US species in danger of extinction grows longer each year, with a dramatic rise in the number of imperiled invertebrates in the 20th century. Fully 68 percent of freshwater mussels, more than 100 species, are threatened, making them the most endangered group of native animals. Fifty percent of native crayfish are threatened, according to the Nature Conservancy (Clancy 1997). The majority of surviving species are highly endangered from alteration of their clear, fast-flowing rivers and streams by federally sponsored dams, channeling and diking that have turned most waterways in the Southeast into muddy ditches and artificial lakes. Pollution and introduction of non-indigenous species of mollusks and crustaceans competing for food have also played roles in the decline of some of these mussels and crayfish. The Hawaiian Islands are home to a variety of colorful and endemic tree snails. Introduction of exotic snail species and habitat destruction have already extinguished many of these, and endangered others.

Many species of butterflies, which are important pollinators, are in decline. The Xerces Blue (*Glaucopsyche xerces*), a beautiful butterfly native to California, became extinct in the 1940s (Stein *et al*. 2000). Eight moth species and two other mainland butterflies are possibly extinct, as are 50 bee species native to Hawaii (Stein *et al*. 2000). Eight mainland butterfly species are critically endangered, and 109 are threatened, according to The Nature Conservancy (Stein *et al*. 2000). Dragonflies and damselflies, which predate the dinosaurs, have also lost ground. Two Hawaiian species are possibly extinct, and 79 more are considered imperiled (Stein *et al*. 2000).

Seventeen species of freshwater fish are extinct or possibly extinct, and the United States leads the world in the number of threatened freshwater fish: The Nature Conservancy lists 283 species (Stein *et al*. 2000). Habitat loss in the form of dams, river diversion and channeling, as well as pollution, has played major roles endangering these fish. Logging has destroyed many clear rivers and streams where salmon and trout breed. The majority of rivers and bodies of water are still polluted despite the Clean Water Act, and contaminants have caused malformations and high mortalities in fish populations. Introductions of non-indigenous fish for sport fishing have imperiled a large number of species. Brown Trout from Europe and Rainbow Trout placed in areas where they are not native have severely threatened native trout, such as the Cutthroat Trout of western lakes and rivers. In many cases, multiple factors combine to push native fish toward extinction.

The United States is second only to Australia in the number of threatened reptiles and amphibians. The Nature Conservancy lists 51 imperiled reptiles and 82 imperiled amphibian species (Stein. 2000). This amounts to an estimated 40 percent of US amphibians, and 18 percent of native reptiles--extremely high rates. Amphibians are declining worldwide from various causes including habitat loss, pollution, disease, pesticides and ultraviolet radiation from thinning of the Earth's ozone layer.

The total of 71 US bird species that BirdLife International's research placed in various categories of threat includes 33 species from the Hawaiian Islands (BI 2000). The Nature Conservancy found an even greater number through their intensive Natural Heritage Program research: 83 species of birds at risk in the United States, or about 11 percent of all native species (Stein *et al*. 2000). This is a smaller percentage than for reptiles and amphibians but, when analyzed by region, a large percentage of Hawaii's birds are threatened. A steady increase in the number of threatened birds has occurred in this century. The major causes threatening US mainland and seabirds are destruction of habitat, pesticides and pollution. In the Hawaiian Islands, introduced animals, disease and destruction of forests and wetlands are the major threats to endemic birds, as well as to plant life and invertebrate fauna.

The Nature Conservancy considers 65 species of US mammals, or about 16 percent of all native mammals, to be threatened (Stein *et al*. 2000). The loss of habitat from development, logging, livestock grazing, mining and other forms of destruction is the foremost threat to mammals. Added to this, pollution affects many aquatic mammals, and predator and rodent control programs to benefit livestock and agricultural interests affect foxes, wolves, and prairie dogs. A growing number of bats have been added to the list of threatened US mammals, an indication of a loss of habitat, as a result of caves being disturbed or vandalized, loss of large roosting trees to logging, pesticide use, and persecution by those not aware of bats™ ecological importance and who have exaggerated ideas of their supposed threats to humans.

Although lists of native North American threatened plants are far from complete, they reflect the rate at which ecosystems have become imperiled. The Nature Conservancy found 6,460 United States vascular plants to be imperiled (Stein *et al*. 2000). Of these, a very large number--1,385--are Critically Imperiled, 1,341 Imperiled and 3,338 species Vulnerable. Hawaii is a center for threatened plants. The *1997 IUCN Red List of Threatened Plants* found a somewhat smaller number of threatened US plants; 4,488 species, or 29 percent of native plants. Still, the United States had the highest number of endangered plants of any country in the world (Walter and Gillett 1998). In terms of the percent of native plants that are threatened, only St. Helena, Mauritius, and the Seychelles had higher rates (Walter and Gillett 1998) Few countries of the world have legislation similar to the US Endangered Species Act, which has helped hundreds of endangered plants.

Many US plants are adapted to specific types of soil or microclimates, and human disturbances can threaten them. Prairie plants are among the most threatened. California's grasslands have been reduced by more than 90 percent, leaving many endangered plants; it has many endemic species in its southern chaparral and shrubland, which are being bulldozed to make way for new housing developments. The state's mild climate and varied landscape have given rise to great diversity, which is extremely threatened. Of 25 presumed and 21 possibly extinct species in the state, about half, or 24, are plants (Stein and Flack 1997). Although endemic plants are not as numerous on the mainland as in some island habitats, North America is home to a great many unique and beautiful plants, which are finally beginning to receive the conservation attention they deserve.

Research is uncovering potential economic value in some native plants. One threatened US plant, the Scrub Mint (*Dicerandra frutescens*), yields a natural insecticide in its oil that repels a wide variety of insects, from ants to cockroaches (Aylsworth 1998). This white-flowered plant is presently restricted to a few hundred acres in central Florida, and it only came under scrutiny in the 1990s, when a Cornell biologist, Dr. Thomas Eisner, discovered its potential as a natural insecticide (Aylsworth 1990). This mint may be protected from extinction in time, thanks in large part to Eisner's research.

In spite of some sizeable natural areas in the United States preserved by the Wilderness Act and as federal or state land holdings, the country has become increasingly urbanized and cultivated for agriculture. Americans have gradually altered the landscape so that much of it, especially in the East, now resembles Western Europe's heavily populated countries where wilderness has been all but eliminated.

Recent ecological research on the effects of suburban sprawl on the environment have shown it to crowd out as many species as more densely populated areas (Revkin 1997). Diversity of species declines in these areas as green

lawns, manicured gardens and asphalt cover the land and pollute the ground water with pesticides, fertilizers and herbicides and kill off beneficial insects and other animals. Developers drain beaver ponds and wetlands and turn streams and rivers into concrete-lined ditches. With each acre lost, species decline. The brilliantly colored warblers and songbirds of eastern forests, for example, have been severely affected by fragmentation of both their breeding and wintering habitats. For the majority of such declining species, endangered listing comes only when they have been reduced to a small fraction of their original populations. The species that are listed by the IUCN or The Nature Conservancy in various categories of threat have reached a point where their very survival is at risk. In some cases, species, which were once described as naturally rare, are very restricted in distribution, especially plants and fish inhabiting desert springs or mollusks found only in a particular river system. For the majority of threatened US wildlife, however, their status a few hundred years ago would have been described as secure. It is all the more indicative of a crisis situation regarding American biodiversity that so many species, and such large percentages of their classes or types, are now headed toward extinction.

Should all US species currently threatened become extinct, a biological tragedy will take place. Preventing such a catastrophe has not yet captured the public™s attention or involved a zealous effort on the part of the US government. Important work on biodiversity studies is being done by various federal agencies, but the major burden of activism regarding preservation of endangered species and the environment has fallen to private conservation organizations.

The WWF report entitled "A Conservation Assessment of the Terrestrial Ecoregions of North America," accuses the US government of "doing a worse job of protecting its biological resources than many poorer countries with few resources for biodiversity conservation" (Luoma 1997). It concludes that the wealthiest country in the world places the preservation of its natural resources among its lowest priorities.

Without detailed information on the biodiversity of this country, it will be impossible to protect it, yet funds are inadequate to carry out a comprehensive assessment. Many opponents of the biodiversity studies in Congress have expressed fear that they would be used to expand the list of species on the Endangered Species Act and obstruct development programs. They succeeded in blocking formation of the National Biological Service, which Clinton Administration Secretary of the Interior Bruce Babbitt had to create administratively. The constant deterioration of the land through development, pollution and introduction of exotic species makes these studies all the more timely. This is a critical time of rapid environmental destruction and a turning point for many species which, without urgent protective action, will follow the deadly trails of the Passenger Pigeon, Carolina Parakeet, Sea Mink and hundreds of other lost plants and animals.

The US Endangered Species Act is one of the strongest and most effective laws in the world and has been a model for similar legislation globally. Many countries, including Canada, still lack national endangered species laws. Although private organizations acquire habitat and carry out many important programs, the legal protection the Endangered Species Act provides is key to the protection of many endangered species and their habitats. It has been responsible for saving a number of species, including the California Condor (*Gyps californianus*), Black-footed Ferret (*Mustela nigripes*), Whooping Crane (*Grus americana*) and numerous other animals and plants. The law has helped fund research, captive breeding, protection in the wild, reintroduction programs, land acquisition and law enforcement protection.

The law must be reauthorized regularly by Congress, however, and at these times, efforts to weaken or even fail to authorize it threaten its effectiveness and very existence. The strong support the law has received from the US public is not always evident in the halls of Congress, where commercial interests and lobbyists have had considerable influence. To date, the law has survived, although it has been amended and weakened somewhat since its enactment. The blocking of listings on the Endangered Species Act by its opponents has become the major means of thwarting the Act. Lawsuits have been filed by both opponents and proponents of the law demanding either delisting of species or listing and critical habitat designation. A virtual impasse has resulted in a moratorium on listing new species which the Department of the Interior declared in 2000.

Many listings have been thwarted by commercial interests. In a recent case, a proposal to list the Lynx (*Lynx canadensis*) on the Endangered Species Act was not acted upon by the Fish and Wildlife Service without a lengthy struggle. This species has greatly declined from its once large range in the lower 48 states. Heavy trapping for its valuable fur and logging of its habitat of mature pine forests have reduced its populations to fewer than 1,000 animals. The majority of Lynx remain in Montana, Idaho, Washington and Maine. Although the Fish and Wildlife Service's (FWS) own biologists found this population to be endangered, they were overruled by headquarters whose bureaucrats decided to refuse to list the species on the Endangered Species Act (Cushman 1998). Petitions by conservationists urging Endangered Species Act listing for the Lynx were ignored, and only when a lawsuit was filed against FWS did the tide begin to turn in this endangered cat's favor. Conservationists won the suit in 1997, but the FWS, in an unprecedented action, declined to list the Lynx, stating that other species had higher priority for listing. Loggers and commercial timber companies oppose listing the Lynx, fearing that areas would be set aside as critical habitat where no tree cutting would be allowed, and many conservationists believed that FWS had succumbed to these pressures. Finally, in February 1998, the Service and several conservation groups reached an agreement to list the Lynx on the Endangered Species Act to take effect in 1999 (Cushman 1998). President Clinton declared a moratorium on new road building in national forests lands in 2000, which will greatly aid the Lynx and other threatened species of these forests, such as the Wolverine and Marten.

The Public Employees for Environmental Responsibility (PEER) issued a report in December 1997 accusing the FWS of failing to protect more than 300 species awaiting listing. Only listings of plants have increased in recent years, leaving a growing number of animals in need of federal listing (Stein *et al*. 2000). The Nature Conservancy's biological surveys have uncovered a far greater number of endangered and threatened species in the United States than are listed by the Endangered Species Act, especially plants.

On the positive side, an increase in the number of endangered species added to the Endangered Species Act has been seen in recent years. The Endangered Species Act, in spite of shortcomings, is vital to the preservation of endangered species in the United States, and it is in grave danger of being weakened so much that it will become ineffective. Various proposals in 2001 made by the Bush Administration would make it nearly impossible for citizens to sue the government to force listing of endangered species (Jehl 2001). The majority of species on the Endangered Species Act were listed as a result of citizen suits (Jehl 2001, Gorov 2001). The Fish and Wildlife Service claims to be unable to perform its duties because of the large number of legal challenges. The law has not been reauthorized since 1991, and proposed changes might leave actions regarding endangered species to the discretion of the Department of the Interior, rather than basing them on biological status. Under the new plan, citizens could petition for listings, but the government would not have to respond promptly, nor would it have to act on designating critical habitats for endangered and threatened species (Gorov 2001). So little money--$6.4 million--is budgeted for listing that a stalemate is inevitable. Other proposals by the Bush Administration would cut overall spending on endangered species programs by $11 million, leaving the Office of Endangered Species without the means to accomplish its purpose (Gorov 2001).

A number of private organizations have aided in preserving endangered and endemic plants not listed on the Endangered Species Act. The Nature Conservancy and its state Natural Heritage Programs have purchased or arranged purchase of hundreds of thousands of acres of land for threatened plants. Arboretums and botanical gardens, such as the Missouri and the New York Botanical Gardens, also are active in this regard. Lady Bird Johnson helped found the extremely effective organization, the National Wildflower Research Center, which aids in the conservation of wildflowers. In the northeast, the New England Plant Conservation Program has spent six years collecting seeds from some 500 rare plants for a seed bank. The New England Wild Flower Society has been instrumental in this program, and many sanctuaries throughout the region are preserving threatened plants.

The actions of individual states under their state endangered species laws and Natural Heritage Programs have also been crucial to the survival of many species that are threatened within a state or region, but might not qualify for federal listing. Programs to reintroduce Bald Eagles (*Haliaeetus leucocephalus*), Peregrine Falcons (*Falco peregrinus*), threatened fish and River Otters (*Lutra canadensis*) have brought back these species in many areas where

they had been eliminated by pesticides, over-trapping, pollution or water projects. Many programs have involved cooperation between state and federal endangered species officials.

Habitat Conservation Plans (HCPs) are agreements worked out between landowners and the Fish and Wildlife Service for listed endangered species under a 1982 amendment to the Endangered Species Act. In essence, they are the result of deals made among developers, state and county officials, Fish and Wildlife Service representatives and local citizen groups on large tracts of land, in which portions of endangered species' habitats are protected, while development is allowed on the rest. HCPs are a permanent contract that cannot be amended, even if biological information is revealed showing that they were in error. These HCPs have been the center of much controversy, considered by some conservationists to compromise the principles of the Endangered Species Act, and by others to be an excellent means of protecting species. HCPs are not presently published in the *Federal Register* prior to signing by the Secretary of the Interior, which would subject them to public comment.

In 1997, a team of 119 scientists, financed by the National Science Foundation and the American Institute for Biological Sciences, carried out careful appraisals of signed HCPs and reported on their conclusions. They found that crucial scientific knowledge was lacking about many of the species involved in these agreements (Yoon 1997). They also found misuse of scientific methods and biological data which will end in harming, rather than helping, many species (Yoon 1997). Dr. Peter Kareiva, a University of Washington ecologist who organized the study, concluded that many HCPs should not have been written, and only about half correctly employed science (Yoon 1997). Of 206 HCPs examined in total, 44 of them in detail, one-third lacked information as basic as life span of species, and the vast majority did not include data on rates of population rise and decline and habitat changes (Yoon 1997). The most glaring problem seen by the scientists was the failure of HCPs to correctly assess the impact of losses to species' populations, mainly as a result of untested methods of appraising impacts. One plan proposed to protect Utah Prairie Dogs (*Cynomys parvidens*) by moving animals to a new location using a method already known to result in the deaths of 97 percent of the relocated animals within three months (Yoon 1997). An HCP for the Desert Tortoise (*Gopherus agassizi*) in Nevada allowed the killing of hundreds of these threatened reptiles by bulldozing their burrows and habitat, while protecting only minimal amounts of habitat.

A major problem faced by those trying to save endangered species is the fact that the vast majority live on privately owned land, and arrangements must be made with owners to insure the survival of these species. Many people believe that protecting these species involves major restrictions on the use of their land and, therefore do not want to enter into Habitat Conservation Plans. Ideally, however, protecting a threatened butterfly or plant on a private ranch, for example, would only involve identifying the habitat, the host plants for the butterfly, and preventing destruction through excavations or other major alteration of the land. In many cases, cattle grazing is compatible with protection of rare species, since the land is not plowed, which can destroy plant life. Ranchers in southern Arizona have cooperated in protecting the land through preventing overgrazing and maintaining riverbank vegetation and springs for rare frogs and birds. For many endangered species, conservation easements are an excellent solution for their protection. These easements involve the payment of funds to the landowner by private organizations, or local, state or federal governments to let the land remain undeveloped and help enhance it as wildlife habitat. This is an especially good solution for farmers who are afraid of losing their land after years of crop failure or low market prices. Innovation has marked many arrangements now being made to protect endangered and endemic species.

The US public as a whole supports the protection of endangered species, which helps explain the Endangered Species Act's survival under strong opposition. Polls conducted in November 1994 by Peter D. Hart Research Associates found that 57 percent of the public wanted to maintain the Endangered Species Act in its present form, and only 32 percent wanted to relax requirements. A September 1995 CNN poll asked which was more important, saving endangered species or saving jobs: 48 percent replied endangered species, and 40 percent, jobs. A Gallup poll carried out for CNN in April 2001 found that support remained strong. It asked Americans whether they supported environmental and wildlife protection even if it meant higher prices or more jobs, and again, a majority supported conservation. They were also asked to rank environmental protection in terms of its importance as an issue, and most placed it near the bottom of the list. When asked whether it would be an important issue in 25 years, however, the

majority said it would be among the most important issues. This reflects a failure to understand the ongoing wave of extinctions that is eliminating many of the Earth's most fragile plants and animals and its possible effect on humans.

Thus, education is extremely important, especially its role in relating American lifestyles and waste of resources to the extinction and endangerment of species. A 2001 film, "Natural Connections" (Howard Rosen Productions, shown on PBS), addresses this issue as well as the gradual diminution of biodiversity. The overconsumption that Americans take for granted impoverishes nature in the US as well as in other countries that export their tropical hardwoods; cut flowers; leather from cows grazed in former rainforests; non-organic, sun-grown coffee; minerals; and handcrafts from scarce materials to this country. Other products are manufactured as a result of polluting the environment and, like coated paper cups or pulp magazines, are used once and thrown away. To maintain such a throw-away lifestyle, millions of trees are cut each year in the United States and elsewhere, disrupting ecosystems and threatening wildlife. Pollution is created from mines that poison rivers, and manufacturing and power plants that spew dioxin and greenhouse gases into the air. The urgency that gave rise to legislation early in the 20th century that protected native birds and other wildlife from overexploitation for commercial purposes was enacted after the extinctions of the Passenger Pigeon and Carolina Parakeet, and near-extinction of the American Bison (*Bison bison*) and other animals from 19th century slaughters. It would be tragic if a similar wildlife or environmental catastrophe were needed to spur strong action to preserve the world's genetic and biological heritage.

Threatened Species of the World

The *2000 IUCN Red List* found 3,507 vertebrates and 1,928 invertebrates in high degrees of threat worldwide (Hilton-Taylor 2000). Plants classified as Critical, Endangered or Vulnerable totaled 5,611 species. These are minimum figures because only birds and mammals have been thoroughly examined for status. When assessments are carried out on the remaining species, the list will doubtless grow far longer.

Many of the most magnificent, graceful, beautiful and zoologically curious animals on Earth are threatened with extinction. A growing number of these, such as sea turtles, sharks and crocodiles, have survived virtually unchanged for hundreds of millions of years, and if not for the human activities that are pushing them toward extinction, they would likely survive millions more.

Almost all the graceful cranes, on Earth since the Miocene Epoch, are endangered from loss of habitat and hunting. The entire family of prehistoric-looking rhinoceros is teetering on the brink of extinction. New Zealand's extraordinary and primitive kiwis and ancient tuatara lizards, which have survived since the dinosaur epochs, may be lost in the next few decades. Eleven of the 16 species of penguins are now threatened, nine in higher categories (BI 2000). Seabirds of many types, including the majority of albatross, are now listed.

The most surprising finding was the high number of mammals listed: 2,046 species, of which 1,130 species were in higher categories of threat (Critical, Endangered and Vulnerable). Thus, of the approximately 4,000 species of mammals, 28 percent are highly threatened, and more than half are in some degree of threat. They are the most imperiled class of animals. Twelve percent of birds, or one in eight species, are listed in higher categories of threat (1,186 species), and an additional 809 species are in lesser categories (Near-Threatened, Conservation Dependent, or Data Deficient), totaling 1,995 species or about 18 percent of the world's birds (BI 2000). Reptiles are a group less well assessed, but 750 species are at risk in all categories, according to the *2000 IUCN Red List*. Amphibians, which number about 4,550 species worldwide, have a minimum of 226 threatened species, and a large additional number that have not been thoroughly assessed. Likewise, very few marine fish are listed by the IUCN because so little is known of their status. Some progress is being made in assessing marine fish, especially coral reef fish and sharks and rays.

By 2003, a complete assessment of the shark family is planned by IUCN (Hilton-Taylor 2000). Approximately 1,183 fish are listed in the most recent *IUCN Red List* in various categories of threat. The majority of these are freshwater species, which represent 6 percent of all known fish.

The rate at which animals and plants are declining has reached such proportions that even familiar species considered common with stable populations only a decade ago are now threatened. The African Lion (*Panthera leo*) and many African antelope, Giraffes and wildebeests are in serious decline, or exist only in parks and reserves, categorized as Conservation Dependent.

Animals listed as Near-Threatened or Data Deficient totaled 3,324 species, of which 2,364 species are vertebrates in the *2000 IUCN Red List*. The grand total of 8,759 vertebrates in all categories comprises 20 percent of all mammals, birds, reptiles, amphibians and fish on Earth. In the early 1980s, only 1,000 vertebrates were listed by the IUCN. This means that in just 20 years, this total has risen by almost 900 percent.

Plants have been assessed in several reports. The *1997 IUCN Red List of Threatened Plants* (Walter and Gillett 1998) was supplemented--and many species reassessed--by the *2000 IUCN Red List* (Hilton-Taylor 2000). Plants from Cameroon, the Galapagos, Mauritius and South Africa were added to the 2000 list. A total of 6,932 plants were listed in all categories, 5,611 in higher categories of threat. In spite of these major undertakings, only conifers were thoroughly assessed. The 1997 study, using one type of definition based on status alone, found 30 percent of all conifers to be either Endangered or Vulnerable; the 2000 reappraisal, using new criteria, determined that 16 percent were threatened (Hilton-Taylor 2000). When far more species of plants are assessed, The Nature Conservancy study of US plants (Stein *et al*. 2000), which found one-third of plants to be threatened, may be indicative of a great decline in the world's plants.

As in the case of animals, many of the Earth's oldest species of plants are at high risk of extinction. Trees that predated the dinosaurs and survive in pockets in Chile, New Zealand, New Caledonia, Australia, New Guinea and parts of Southeast Asia are being destroyed, with little knowledge of their extreme botanical importance. Many of these are among the largest trees in the world, rivaling the Redwoods in height and the Sequoias in girth (see Forests chapter). Others, such as the monkey puzzle tree family, are extremely bizarre in appearance, and may contain important compounds for medicines. Beautiful primitive flowers, the protea, are also greatly threatened, with many species growing in South Africa. Tree ferns, palms and hundreds of orchid species are also highly threatened. The island of Mauritius has a large number of threatened plants, many of which are quite unique.

Many zoologists and conservationists are now resigned to the rising level of extinctions and believe that, within a century, 80 percent of all species living today will be extinct. Such predictions may be overly pessimistic, but unless the public is made more aware of the precarious status of a growing number of plants and animals and demands strong action, the prognosis may be fulfilled.

What is Threatening Species?

Human activities are at the root of virtually all extinction threats. Destruction of fragile habitats, wetlands, coral reefs, tropical and temperate forests, rivers and grasslands has accelerated in recent years due to human population increases and commercial exploitation of forests, ocean fish and other wildlife, as well as the introduction of non-native species, either intentionally or accidentally. The massive pollution and chemical contamination of air, water and soil--and even the atmosphere that surrounds the Earth--are altering the climate and bringing about

unforeseen declines in wildlife and plants.

Human Tragedy and the Looting of Virunga's Treasures

What is Threatening Species? Human Population Growth

Burgeoning human populations provide the major impetus for destruction of the last havens for rare species. In 1650, when Dodos were still common on the island of Mauritius, the world's human population totaled about 500 million, half of India's present population. Two hundred years later, the number had doubled to 1 billion. In 1900, the world's population totaled 1.6 billion. Since then, it has taken shorter periods for the world's population to double, and at present it doubles approximately every 37 years. In 2000, 6 billion people lived on Earth, a number expected to rise to between 8.5 and 9.4 billion by 2050. While population growth has leveled off in parts of Europe, Russia and Australia, it continues to rise in the United States, mainly as a result of immigration. The highest rates of growth, 3 percent or more, occur in Africa, Asia and Latin America, where environmental deterioration has been severe. The similarity between the astronomic rise in human population and the extinction rate of animals and plants is not accidental.

Settlers in increasing numbers are entering tropical forests, grasslands and other wild areas teeming with wildlife, and clearing them for grazing livestock and planting crops. Loggers in the Brazilian and Central African rainforest wildernesses are building roads to transport entire forests of trees, some thousands of years old, to be sold in markets in North America, Europe and Asia. The roads open up the forests to settlers and hunters, endangering countless species of animals. Commercial exploitation of forests has increased rapidly since the 1980s, with logs turned into pulp for paper, expensive lawn furniture, paneling, shipping cartons, and even concrete molds that are used once by builders and thrown away. Rivers are becoming increasingly polluted from human waste that goes untreated in many

parts of the world, and billions of people scratch out a living by subsistence farming, cutting trees for fuel and grazing livestock.

These poverty-stricken people have caused the limits of the Sahara and Sahel in Africa to expand by depleting wildlife and trees, and have razed forests in India, China, Indonesia, Thailand, Ecuador, Central America, Mexico and West Africa. Still, many go hungry because they have far outstripped what the land could supply sustainably. For the wealthier nations, an appetite for material goods and demand for a high standard of living have encouraged a market for precious resources, such as tropical lumber and wildlife products, that has expanded in recent years with the World Trade Organization (WTO) globalized economy. In order to repay loans granted to them by international funds, many poor nations strip their forests and grow exportable crops on the land. In the United States, urban sprawl and overexploitation of forests and other resources have threatened a host of animals and plants. Water is diverted for these new towns, endangering native fish and forests. In Arizona, the Sonoran Desert, a botanical world treasure, is now being destroyed by the expanding cities of Phoenix and Tucson.

The needs of the growing numbers of people worldwide have spawned many ill-conceived and environmentally destructive projects. Indonesia and Brazil opened up the most biologically rich forests on Earth to farming by people living in overpopulated cities. The soil is poor in tropical forests, and they must keep clearing land to find new areas for crops, gradually destroying vast areas once teeming with wildlife. China has moved people into western grasslands, where they have eliminated wildlife and caused massive erosion and desertification with agriculture and overgrazing of livestock. Dust storms from this region have been circling the globe in recent years. China has also commissioned the world's largest dam, Three Gorges--on the Yangtze River--in an attempt to control floods and generate electricity. In the process, a very rare freshwater dolphin, a sturgeon, and hundreds of rare plants will become extinct, and the dam's lake will fill with untreated sewage. The problem of overpopulation has not been well understood or coped with in the majority of countries where populations are now outstripping food supply.

In most parts of the world, however, people have deforested the habitats and killed prey species of wide-ranging wildlife that have nowhere else to go. Asian Elephants (*Elaphus maximus*) and Tigers (*Panthera tigris*), for example, have been deprived of habitat and food and crowded into areas too small for their requirements. When they rampaged into people's gardens or killed livestock, they were killed and their body parts sold for high prices. Both species are now endangered, their populations fragmented and in steep decline. This is a pattern that has been seen with large animals, especially predators, throughout the world. Animals or plants with low populations as a result of restricted habitat size or specialized requirements for survival have been pushed to the brink of extinction as humans moved into their habitats.

Only a few countries have national policies to encourage stable populations. In some countries with populations that far exceed the ability of the land to adequately sustain them, wars have broken out, providing an apocalyptic vision of a violent future for the Earth should present trends continue. A scientific study, *Environmental Change and Violent Conflict* (Homer-Dixon *et al*. 1993), predicted that as human populations increase and resources decrease, wars will occur with ever greater frequency. Population Action International, a Washington, DC-based organization, calculated in 1997 that although human population growth has slowed somewhat, water resources remain under serious threat. This organization's report warns that by 2050, people in the Middle East and parts of Africa, where populations continue to grow at high rates, will be engaged in bitter, violent conflicts over water. The story of the Rwandan war, described later in this chapter, reflects this cause and effect. Overpopulation causes human suffering, permanent damage to the land from overuse, and the destruction of the very species that might prove life-saving. A few countries, such as Singapore, launched education programs decades ago, urging people to have smaller families for a better quality of life. The rate of population increase in this tiny country is now less than 1 percent, and literacy is 91 percent.

Medical advances preventing disease and early mortality in people around the world, combined with growth in agricultural output, have played a major role in the nearly four-fold rise in human population since 1900. The World Health Organization (WHO) has scoured the planet eradicating disease but is not required to educate people about

birth control methods. This has decreased natural mortality and fueled population booms. The majority of international aid projects lack overview, coordination with one another and long-term planning. Supplying high-yield grain and financing irrigation projects to poor nations, without providing birth control education, results in a doubling of populations within a generation, which negates any rise in the standard of living and education levels. By encouraging livestock and agriculture in dryland areas, with little knowledge about the natural environment or its capacity to support large numbers of people, wildlife and plants are displaced or killed, and in years of drought, crop failures result, causing starvation. The human suffering brings international aid with emergency food, and instead of relocating people to other areas, these programs encourage replanting and a repetition of the misfortune.

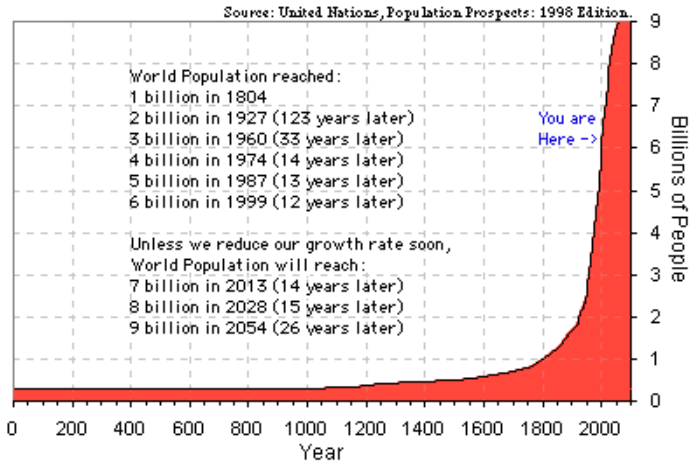
Ethiopia and Somalia are examples of such policy failures. These countries were covered in a mosaic of grasslands and forests teeming with endemic wildlife early in the 20th century. An influx of large numbers of people and livestock, encouraged by aid programs, denuded this region to arid desert. The vast numbers of wildlife have largely disappeared or become endangered as the extensive grasslands, rivers, lakes and highland forests disappeared because of overgrazing, farming in areas too dry to produce crops and deforestation for firewood (see Grasslands, Shrublands and Deserts chapter). With low human and livestock population densities, these areas could have remained ecological treasures.

The Population Institute of Washington, DC, warns that although some countries have shown declining rates of population increase, especially those in Western Europe and North America, this will not result in an overall decline in world population because of greater human longevity, continued high birth rates in at least 74 countries and a high survival rate (Holmes 1997).

The top 10 countries in terms of overall numbers of people have 59 percent of the world's population. More than 30 percent of all births in 1997 took place in India, a country expected to overtake China as the world's most populous nation by 2050 (Holmes 1997). A 1997 World Bank report, "The World Food Situation: Recent Developments, Emerging Issues and Long-Term Prospects," concluded that food stocks are not keeping up with need (Crossette 1997b). Demand for meat is increasing, placing further stresses on natural systems since livestock consume enormous amounts of grasses and grain, cause damage to vegetation and often pollute water systems; grain production is reaching the limit of potential yields, especially in Asia (Crossette 1997b).

The most densely populated country in the world, Bangladesh, with 127.5 million people, has about half the population of the United States in an area the size of Wisconsin. It has a density of almost 3,000 people per square mile, and a population growth rate of 2 percent a year. Ninety percent of the people in Bangladesh's countryside are illiterate and malnourished in spite of decades of international aid projects. Bangladesh is now totally dependent on foreign aid for minimum nutrition, and the land is being worked to maximize yields, using large quantities of fertilizer, irrigation and pesticides. The once vast mangrove forests that serve as fish and shellfish nurseries, and habitat for Tigers and other endangered species, are being destroyed piecemeal, cut for firewood (Worker 1996).

Funds to encourage birth control around the world have been deleted from US budgets by those opposed to abortion, thus thwarting all types of programs of education, birth control methods and related issues. Most organizations working to lower birth rates around the world use almost no funds for abortion, yet they find their funds cut for all family planning programs. This obstructionism has been a major setback to those working to stabilize the world's populations. The United Nations Population Fund has continued to carry out family planning programs, but with inadequate funds.



What is Threatening Species? Habitats Under Threat

Habitat destruction is the foremost threat to wildlife. In broad terms, more than 85 percent of IUCN-listed birds, mammals and plants are threatened by habitat destruction and degradation (Hilton-Taylor 2000). The greatest number of threatened species listed in the *2000 IUCN Red List* inhabit terrestrial areas. They total 9,256 highly threatened species. The largest single terrestrial group is plants, with 5,607 species; birds follow, with 1,144 species; with mammals having only slightly fewer threatened species, 1,111 (Hilton-Taylor 2000). The vast majority of threatened birds and mammals are terrestrial species. The destruction of forests is the single most important threat to birds, affecting 75 percent (BI 2000). At least 900 of the 1,144 threatened birds inhabit tropical rainforests, with almost half of those species restricted to lowland rainforests, and 35 percent in montane rainforest (BI 2000). Authors of *Threatened Birds of the World* (BI 2000) found that the vast majority--86 percent--of rainforest birds cannot tolerate much habitat destruction, and 45 percent require near-pristine habitat. Only 3 percent are highly tolerant of habitat alteration (BI 2000). Unsustainable selective logging affects 31 percent of threatened birds. In many tropical forests, logging and forest burning are taking place without any restrictions, totally eliminating habitats of rare rainforest birds. A total of 4.5 million square kilometers, or 20 percent of the world's forests, were cleared from 1960 to 1990 (BI 2000), and since then, forests--especially tropical forests--have continued their decline. Although some forests may return to old-growth hundreds or thousands of years in the future, much of the land is being converted to agriculture, grazing land, housing, cities, industry and roads and is unlikely ever to revert to forest.

Likewise, more than half, or about 57 percent, of threatened mammals inhabit tropical rainforests, 35 percent in lowland, and about 22 percent in montane rainforest (Hilton-Taylor 2000). Less than 10 percent of threatened birds and mammals are native to temperate mixed forests, coniferous forest and temperate broadleaf forests, according to the IUCN. A very small number of threatened mammals, about 3 percent, inhabit tropical degraded forest, a sign of the unsuitability of this habitat (Hilton-Taylor 2000).

Forests are also home to a wide variety of threatened frogs, salamanders, tree snails and insects, although studies of which type of forest each inhabits have not been done by the IUCN. Many endangered plants are tropical species, native to islands such as Madagascar and Indonesia, where endemic plants such as orchids and palms abound, and habitat destruction is severe. The United States leads the world in threatened plant species, with 4,669 identified by the IUCN in its 1997 study (Walter and Gillett 1998) and 7,817 species listed by The Nature Conservancy (Stein *et al.* 2000). Many of the latter are in Hawaii, another tropical island with a high percentage of threatened plants. Lobelias are known for their beautiful flowers, and the ancestor species that arrived in the Hawaiian Islands radiated into 273 species, some of which grew to the heights of small trees. One-quarter are gone, and another 124 of the surviving

species are threatened with extinction or possibly are extinct (Walter and Gillett 1998). Of the remaining lobelias, only 27 percent now have sizeable enough populations to keep them from extinction; the loss of their pollinators, most of whom were honeycreepers, is a major cause (Buchmann and Nabhan 1996). The honeycreepers lost their forest habitats to clearance by settlers, and as they faded into extinction--one species after another--lobelia plants they had pollinated disappeared or became endangered. These ecological webs exist throughout nature.

The IUCN found that 91 percent of plants identified as threatened were endemic, with their entire distribution restricted to a specific country (Walter and Gillett 1998). A total of 32,242 threatened or extinct species of plants occur in one country alone, while 2,368 occur in two countries, and only 709 plant species occur in more than two countries. Only scanty information on threatened plants is available from most countries in South America, Africa and Asia, which are expected to have large percentages of their native plants found to be threatened when assessed (Walter and Gillett 2000).

Grasslands, shrublands and savannahs are the second most important habitat for threatened birds, home to 383 species, or 32 percent of all listed species (BI 2000). Two-thirds of these birds inhabit shrublands; 43 percent, grasslands; and 8 percent, savannah (BI 2000). Three-fourths are tropical birds, whose habitats are threatened by livestock overgrazing, human settlement and farming (BI 2000). Some 17 percent of threatened mammals inhabit grasslands, while another 8 percent are shrubland species, and about 7 percent are native to desert and semi-desert (Hilton-Taylor 2000).

Freshwater habitats, such as rivers, marshes, bogs, streams and ponds are the second most important biome, after terrestrial, for threatened species. At least 1,946 threatened species, the largest number being fish (627 species) inhabit these areas (Hilton-Taylor 2000). Freshwater crustaceans (409 species) and mollusks (420 species) are major inhabitants of these aquatic areas, as are 131 amphibians, 111 reptiles, 78 birds and 31 mammals, according to the *2000 IUCN Red List*. The United States, with its extensive water projects--dams, levees, diverted and channelized rivers--harbors large numbers of threatened crustaceans and mollusks, as discussed above.

Frogs make up the majority of threatened amphibians and have been in decline for several decades. Their habitats are being destroyed at an unprecedented rate as wetlands are filled in--half of US wetlands that were present in colonial times--are gone. Thailand has lost almost all its wetlands, and Southeast Asian lakes and marshes are being drained at an unprecedented rate, threatening frogs and other wildlife. Frogs have been on Earth for 190 million years, but at the present rate of decline, the majority of the approximately 4,500 species will be gone within decades. In addition to habitat loss, a variety of threats are eliminating them (see Non-Native Species, Trade and Pollution sections below).

What is Threatening Species? Non-Native Species Introductions

Invasive species, or alien, non-native animals and plants introduced into ecosystems, present the most important threat to plants. The large numbers of threatened species that have limited distributions are highly vulnerable to the possibility of invasive species eliminating them from the wild. Islands have the greatest percentage of their native plants in danger of extinction. St. Helena, a small island in the South Atlantic, leads these in percentages, with 13 percent extinct or extinct in the wild, and 68 of 165 native plants and trees threatened (Walter and Gillett 1998). Livestock played a role in the extinctions and present status of many native plants (see Chapter 1). Mauritius follows, with 39.2 percent of native plants in danger, or 294 of 750 species (Walter and Gillett 1998). Other islands with many native plants threatened by exotic species include the Seychelles, Jamaica, French Polynesia, Pitcairn, Reunion and New Caledonia (Walter and Gillett 1998). Of the latter islands, all but French Polynesia and Pitcairn formed part of Gondwana, and many of the plants at stake are very ancient in origin.

One endemic Mauritian palm, *Hyophorbe amaricaulis*, has been reduced to a single plant. Although it grows vigorously and produces male and female flowers at different times, no fertile seeds are produced (Stearns and Stearns 1999). At the National Agricultural Station in Ireland, botanists cultivated the tiny embryonic growths found within the immature fruits; it is hoped that clones of the palm can be grown to adulthood (Parnell *et al*. 1986). Introduced animals and plants have taken over Mauritius and Rodrigues so completely that a number of species have been reduced to as few as two remaining plants.

Hawaii's native forests and plants have fared poorly, too. Native sandalwood forests were cut by early settlers, endangering several species. The most fragrant of these trees, the Iliahi (*Santalum haleakalae*), is now restricted to the dry lava slopes of eastern Maui. Its carmine red clusters of flowers have the same aroma as its fragrant heartwood (Daws 1993).

Seven or eight types of lobelia plants of the genus *Delissea* once flourished in Hawaii, and all became extinct by 1966 except one, *Delissea undulata*, which had become reduced to only a few plants. Conservationists fenced these plants in 1967 from the browsing cattle and rooting pigs, and they were thought secure (Carlquist 1980), but by 1995, the species' population had declined to a single plant. Botanists found it hanging by a few roots inside a sinkhole, the fence damaged and broken. The fence was repaired, and botanists are germinating seeds, hoping to prevent its extinction (Royte 1995). Another Hawaiian plant, *Cyanea pennatifida*, is in the same perilous status. Native to the mountains of Oahu, it also became reduced to a single plant, which was not producing its green flower. A botanist took a small sample of plant tissue and successfully cloned it in a test tube (Lipske 1997). Dozens of these plants have been cultivated from the slip, some of which were reintroduced into a preserve in 1995 (Lipske 1997).

Two hundred native Hawaiian plants are listed either on the US Endangered Species Act or are candidate species. Some 115 species have only 20 individual plants scattered in different areas or just one population of 50 or fewer plants in one location (Lipske 1997). Livestock and exotic plants have destroyed these plants and their habitats. One of these extraordinarily rare plants has been eliminated from all its original range, and the last members of the species cling to a single vertical cliff along the coast of Kauai, with its roots growing horizontally into rugged rocks (Carlquist 1980). This unusual lobelia, *Brighamia insignis*, has a thick, woody stem which tapers to a rosette of leaves, and it has lost its natural pollinator, which may have been a bird or an insect. Located 2,000 feet above crashing surf, it is out of reach of goats and pigs, but difficult for botanists to reach. This spectacular landscape is now this lobelia's sole habitat. Each year, botanists Steve Perlman and Ken Wood risk their lives by scaling the cliff, using climbers' ropes, to collect pollen from the plants with a brush. They then rappel to a neighboring plant to pollinate it, and months later, they must climb back up to collect the seeds, which are being placed into cultivation (Daws 1993; Royte 1995). Some of these seeds have successfully grown into plants at the National Tropical Botanical Garden on Kauai (Lipske 1997). This may be the most arduous and life-threatening plant conservation program in the world.

On the island of Guam, the forests have not been destroyed, but the bird life has been virtually eliminated by an insidious exotic animal that arrived in the 1960s or earlier. Several Brown Tree Snakes (*Boiga irregularis*) somehow secreted themselves in a shipment from their native Indonesia, and once on the island, they began to multiply. These snakes proved to be an environmental nightmare of the worst proportions, climbing trees and killing and consuming nestling and adult birds, and increasing at alarming rates. They have also caused major problems for the people of Guam. Ascending telephone poles, Brown Snakes short electrical wires. Between 1978 and 1990 alone, 1,000 power outages on the island were caused by these snakes (Jaffe 1994). A major threat to children, they enter homes, biting babies in cribs, and consuming pets. Untold millions of these snakes now live in virtually every environment in Guam. By 1981, these snakes had eliminated native birds from most of the island except for a remote part in the north. The snakes obliterated nearly the entire avifauna of Guam, an estimated 750,000 birds. Once a verdant tropical island teeming with birds, the forests have fallen silent. Three birds became extinct: the Guam Flycatcher (*Myiagra freycineti*) and two distinct subspecies of birds that survive on other islands: the Guam Bridled White-eye (*Zosterops conspicillatus conspicillatus*) and the striking chestnut, black-and-white Guam Rufous Fantail (*Rhipidura rufifrons uraniae*) (Jaffe 1994). The flycatcher was the greatest loss because it left no subspecies on neighboring islands. The Guam Kingfisher (*Halcyon cinnamomina miyakoensis*) became extinct on the island as well, but fortunately, a small

number had been taken into captivity. These kingfishers have been kept at several US zoos, but although they have produced some young, they have exhibited abnormal behavior, such as cannibalizing their chicks, and some have succumbed to avian tuberculosis.

The Guam Rail (*Gallirallus owstoni*) escaped extinction by a hair's breadth. The rail's population declined to about 2,000 birds by 1981, and in 1983, fewer than 100 remained; the last wild birds disappeared by 1987. The Guam Division of Aquatic and Wildlife Resources captured 19 rails in 1984 and, after captive breeding and holding, began releases in 1995 of 30 to 50 rails every three months on the neighboring island of Rota (Line 1995). Rota, a 209-square-mile island, is snake-free, but only one-fourth the size of Guam. Its forest is mainly intact (Line 1995). In 1999, the introduced Guam Rails bred on Rota for the first time (BI 2000). A small area of 24 hectares on Guam has been fenced off from snakes, and Guam Rails introduced there have also bred (BI 2000). About 180 birds survive in 14 zoos in the United States (BI 2000).

To date, no effective control has been found to rid Guam of the Brown Tree Snake. Metal bands on nesting trees of endangered birds and high-voltage electrical wires meant to kill them on contact have hardly made a dent in their populations. A native bird at the edge of extinction, the Marianas Crow (*Corvus kubaryi*), declined on Guam from 351 birds in 1981 to just seven in 1999 (BI 2000). On neighboring Rota, only 592 survived in 1995, down from 1,318 in 1981 (BI 2000). Guam still has a high percentage of forest cover and many aquatic habitats intact. Among the few mammals on Guam, the Marianas Flying-fox (*Pteropus mariannus mariannus*) has also declined, with a population in the mid-1990s of only about 300 animals. They suffered the effects of heavy hunting by the people of Guam for food, and the Brown Tree Snake is now killing juvenile bats. The endemic Guam Flying-fox (*Pteropus tokudae*) is now extinct, last seen in 1968. It was a probable victim of unrelenting hunting by natives for food but may have been killed off by the Brown Tree Snake. Shrews and other rodents and monitor lizards are disappearing from Guam as well (Jaffe 1994). Since many of the birds and bats served as pollinators of native trees and plants, these species may die out as a result.

Invasive species, mainly those introduced by humans onto islands, caused virtually all avian extinctions over the past few hundreds years. Today, almost 30 percent of threatened birds, or 298 species, are affected by introduced predators, particularly cats, rats, mongooses and other animals (BI 2000). Livestock introduced into avian habitats represents a major threat to 72 species of birds, and 71 bird species have been adversely affected by the introduction of invasive plants that eliminated the food or habitat of plants on which these birds depended (BI 2000). Pathogens, such as diseases and parasites, brought into avian habitats by various means threaten an additional 69 species of birds (BI 2000).

Introduced species threaten fewer mammals, about 69 species, or 10 percent of those listed by the *2000 IUCN Red List* (Hilton-Taylor 2000). This may be because far fewer mammals inhabit islands, compared to the number of native birds, especially flightless ones. Even sizeable islands, such as New Zealand, had very few native mammals prior to human colonization. Madagascar is an exception, with a very large diversity of primates and other mammals, a large number of which are now extinct because of invasive species, along with many other factors (See Islands chapter).

What is Threatening Species? Persecution, Hunting and Trade

A total of 367 species of birds are threatened by hunting for food (233 species) and trapping for the cage bird trade (111 species) (BI 2000). The majority of birds that are threatened by meat and feather hunting are Asian pheasants, grouse, partridges, bustards, guans, megapodes and other large birds (BI 2000). The family of birds most threatened by trapping for the cage bird trade is the parrot family, Psittacidae, with 57 percent of threatened species trapped for this trade (BI 2000). These parrots are native to Mexico, Central and South America, Africa, Asia and Australia, and

some have been pushed to the edge of extinction (See Trade chapter). The Spix's Macaw (*Cyanopsitta spixii*), for example, had been reduced from several hundred birds in the wild in Brazil to a single male when he, too, was illegally trapped in late 2000. This species is now extinct in the wild.

Hunting and capture for commercial purposes threatens 212 mammal species (Hilton-Taylor 2000). Many mammals have been endangered by hunting and persecution, including a number of large predators. The number of bats on the threatened list has grown dramatically in recent years, with many fruit bats threatened by killing for food, and others by vandals or those who persecute them for supposed threats to human health. Trade affects about 29 percent of threatened mammals (Hilton-Taylor 2000). Both the Asian (*Elephas maximus*) and African Elephant (*Loxodonta africana*) species have been reduced to endangered status primarily as a result of killing for their ivory and meat. The 1989 listing of the African Elephant on Appendix I of the Convention on International Trade in Endangered Species (CITES) succeeded in putting an end to more than 90 percent of trade in ivory, which was pushing this species rapidly toward extinction. Since then, the ban has been weakened by pressure from ivory traders, and CITES allowed trade in stockpiled ivory taken from smugglers in southern Africa. This had the immediate result of increasing poaching of elephants throughout the continent, in anticipation of a lifting of the ban.

All rhinoceros species, two native to Africa and three to Asia, are critically endangered. Populations of the five species together total only about 12,000 animals, a result of heavy hunting for their horns, which are used in Traditional Medicine (TM) and as handles for daggers in the Middle East (see Trade chapter). The toll of animal species killed for meat, trade and the TM market numbers in the millions, of which a growing number are threatened. Tigers, Leopards and other wild cats, snakes, pangolins, monkeys, birds of prey, deer, seahorses, and turtles, and many other species are killed to supply this market. The Tiger is poached throughout its range because its body parts are worth $10,000 or more when sold in this market and as trophies. This species is killed in parts of its range by slow-acting poisons and leghold traps for trade, and predator control when it has hunted livestock after its natural prey was killed off. Species like the Tiger, which require large territories and are suffering high mortality from hunting throughout its range, as well as loss of habitat, are in imminent danger of extinction. Several conservation programs are attempting to stem the tide in favor of the Tiger and reduce demand for its body parts in TM. Stricter laws are needed throughout the world, however, to protect endangered animals. The bushmeat trade is a major threat to Central and West African mammals and a wide spectrum of species in Southeast Asia (see Persecution and Hunting chapter).

A thriving trade in terrarium frogs has resulted in a worldwide market for many species of these amphibians. The world's largest frog, the Goliath Frog (*Conraura goliath*) of Central Africa, weighs 7.2 pounds and reaches a length of at least 32 inches; it is found along major rivers in dense tropical rainforest in Equatorial Guinea and southwest Cameroon (FWS 1991). Throughout its range it is very rare, and it has unusual habitat requirements. It needs rapids and cascades with sandy bottoms and very clean, oxygen-rich water; deforestation has reduced this habitat. Collectors have offered huge sums up to $2,500 for capture and export of Goliath Frogs--as personal pets or for public exhibition. One US dealer imported 50 of these frogs and attempted to enter them in the Frog Jump Jubilee in Calaveras County, California (FWS 1991). The Endangered Species Act lists this species as Threatened throughout its range. The IUCN lists it as Vulnerable on the *2000 IUCN Red List*. Hundreds of other species are collected for this trade, threatening many, including various mantella frogs of Madagascar, coveted for their golden color (See Islands chapter).

Although more reptiles than amphibians are killed for their skins, amphibians are now also being taken in large numbers for this purpose. In 1985, the United States imported more than 11,000 frog and toad hides and products worth $350,000 for the luxury trade in frog skin wallets, toad leather boots and other items (Fitzgerald 1989). Most of these skins come from a large Malaysian frog (*Rana macrodon*), but the Black-spined Toad (*Bufo melanosticus*) and other species are used as well (Fitzgerald 1989). Such products are extremely difficult to identify by species, making enforcement difficult.

Frogs are killed by the millions for high school biology class anatomy lessons, an unnecessary toll because

computer programs and films now provide this information (see Projects section). For the restaurant trade, frogs are killed in even greater numbers. Indonesia and Vietnam are the major sources of frogs for restaurants and food markets in Europe and the United States. Prior to export bans, Bangladesh and India captured many millions of frogs each year for the restaurant trade. Several documentary films have recorded the process of removing the frogs' legs in Bangladesh and Indonesia; the same methods were used in each country. Once captured and gathered in large containers, the frogs' back legs are sliced off with a sharp knife or machete, and the still-living frogs are tossed into heaps, where they continue to struggle for long periods before dying. An increase in malaria was documented in Bangladesh after the frog trade caused declines in wild populations; the frogs had been controlling mosquito populations.

The Indian Bullfrog (*Rana tigerina*), a species native to southern Asia, was listed on Appendix II of CITES after heavy trade depleted it. Some of these shipments were seized: In July 1997, a shipment from Vietnam containing the legs of 450,000 Indian Bullfrogs was intercepted in Holland as a CITES violation; the container with the frogs' legs weighed almost 20 tons and was en route to a wholesaler in Canada. This shipment alone represented frogs from vast areas in Vietnam, depleting wetlands of these ecologically important amphibians. Even in US National Parks, frogs are commercially hunted. In Florida, for example, frog hunters in airboats capture millions of frogs during night hunts. In February and March 1996, 6 tons of frogs were taken from Big Cypress National Preserve for sale to restaurants and for private consumption, according to environmental groups which have petitioned the National Park Service (NPS) to end or limit this hunt (Dodds 1996).

The reptile product trade placed virtually all large crocodilians on the endangered list by the early 1970s after imports of millions of skins for luggage, shoes and handbags nearly caused extinctions of species in South America, Africa and Asia. Although controlled to some degree by CITES, a large percentage of trade is illegal, composed of protected species (see Trade chapter). The luxury trade in these products is now threatening many snakes as well as lizards, whose skins can be sold for very high prices. These reptiles, which play important roles in nature--culling rats and other rodents and preventing overpopulations of fish--are taken from the wild. Snakes are being captured in such numbers for this trade and for the Asian medicine and restaurant trades that they have disappeared from areas where they had been common. (See fiEndangered and Threatened Species of Mammals, Birds, Reptiles and Amphibiansfl in the Appendix for an extensive list of these reptiles now threatened with extinction.)

What is Threatening Species? Pollution and Disease

Pollution by acid rain and acid from coal mines that drains into streams and rivers, heavy metals, PCBs, dioxin and other toxic chemicals, have killed off all life in waterways in many parts of the world. PCBs and pesticides have caused serious genetic malformations in frogs, birds and fish.

Frogs have been dying from fungal diseases and the indirect effect of other pollutants, which are eliminating entire species. Necropsies done on frogs from Australia and Panama, which were found dying, have revealed the presence of the same fungus, chytrid (Morell 2001). It is considered responsible for the extinction of several Australian frogs, including the extraordinary Gastric-brooding Frog (*Rheobatrachus silus*) and three other species, and has infected frogs in Panama as well, eliminating populations and possibly species (Morell 2001). This fungus has been detected in 44 species of Australian frogs and is apparently spreading in many parts of the world. Other fungi and viruses have eliminated frogs in the United States (Morell 2001). These diseases have long been in the environment, and it is not yet clear why they have become so toxic and virulent to frogs. Frogs have thin skin and easily absorb chemicals, making them vulnerable, but apparently their immune systems have been weakened, as well. Frogs and toads are also threatened by pesticides, which have been shown to cause grotesque deformities and mortality. Many types of pollution, including acid rain, heavy metals and fertilizers, have eliminated frogs in many parts of Europe and Canada

(Morell 2001). Ultraviolet radiation (UV) suppresses frogs' immune systems and kills eggs as well as adults. Andrew Blaustein (1994), an American biologist, conducted experiments that proved UV to be responsible for wiping out many species of frogs in the US West who laid their eggs in the open. The eggs were thus exposed to this radiation, which has intensified as a result of the decrease in the ozone layer caused by chloroflourocarbons, used by industry in air conditioners and refrigerators, among other industrial uses (see Aquatic Ecosystems chapter).

Hawaiian birds have been seriously affected by avian malaria, brought to the islands by captive cage birds, as discussed in Chapter 1. This disease continues to threaten the surviving species of native birds, and is a major cause of the wave of extinctions that is claiming one species after another of these beautiful songbirds (BI 2000). Several species, such as the Nukupu'u (*Hemignathus lucidus*), are now in Critical status, possibly extinct on both Kauai and Maui where, until the 1990s, a few birds were seen in their montane forests (BI 2000). Feral pigs in their habitats facilitate the spread of alien plants and introduced, disease-carrying mosquitoes (BI 2000).

What is Threatening Species? Traits of Vulnerable Species

By identifying the traits that characterize species likely to become endangered or fade to extinction, it is possible to afford them and their habitats extra protection and carefully monitor their status. The tragic losses of so many of these "red flag" species should be avoided in the future, and can be, with remedial action. Ideally, species should be conserved when their populations are still healthy, before they become genetically impoverished and their populations fragmented. The list below includes some of the characteristics many extinct and endangered species possess. Undoubtedly, the more we learn about the causes pushing wildlife and plants to extinction, the longer such a list will become.

1. Endemic species, or animals and plants that are restricted to a relatively small area, such as an island, are inherently vulnerable to extinction. They have incurred the greatest number of extinctions in the past 400 years. Changes in their habitat or losses to their populations can eliminate them. Many of these species were confined to areas that measured only a few square miles. Mainland species, likewise, can be endemic to small areas. The Slender-billed Grackle (*Cassidix palustris*) once inhabited a single marsh near Mexico City. The marsh was filled about 1910, spelling extinction for this bird. Many endangered species fall into this category.

2. Specialization of habitat or diet has caused much extinction. Animals that depend on a certain type of habitat or food source and cannot adjust to alterations, whether natural or human-caused, are extinction-prone. The Ivory•billed Woodpecker requires large expanses of old-growth forests with many dead and dying trees. The endangered Kirtland's Warbler (*Dendroica kirtlandii*) of Michigan will colonize only one type of forest: stands of jackpine trees that are eight to 22 years old on well•drained, sandy soil. This habitat must now be artificially maintained to prevent the bird™s extinction. The Palila (*Loxoides bailleui*), a Hawaiian honeycreeper, is dependent on the mamane tree for feeding, which has declined as a result of logging and destruction of seedlings by introduced game species and livestock. Many endangered plants require specific soil type, climate, drainage and sunlight exposure. For those species that require unbroken stretches of habitat, such as old-growth forest, endangerment or extinction can result if the forest is fragmented.

3. Long•lived species with low reproductive rates and low natural mortality are vulnerable to extinction. Fast-reproducing species that have many young at frequent intervals and high natural mortality rates tend to be more resilient to population losses and recover quickly if their habitat has not been destroyed. Not all vertebrates fall easily into these categories, but many do, and these groupings can be at least one indication that is useful in terms of predicting which species will become endangered when their populations are reduced. Slow-reproducing animals decline rapidly from losses in their numbers, and since they often do not breed until a relatively advanced age and

have few young, many decline to extinction. In some cases, such animals do not recover their former abundance, or recover very slowly. A few of these animals, including sea turtles, lay many eggs, but only a small percentage of the hatchlings survive to adulthood. Although few of the now extinct animals were ever studied in the wild, enough is known of related species to guess that many fell into this category. The Steller's Sea Cow (*Hydromalis stelleri*), for example, was a member of the Order Sirenia of manatees and Dugongs. The surviving species have few natural enemies, do not breed until age 7 to 10 years old, and have only one young every five years. Hunting caused the extinction of Steller's Sea Cow in the space of a few years, eliminating the only cold-water member of this family. Hunting threatens surviving species of this family in many areas. Manatees and Dugongs are very slow-moving, making them easy targets. The Steller's Sea Cow may have numbered only a few thousand animals in its limited distribution near islands in the Bering Sea. Even when able to swim away, they refused to leave their mates, beaching themselves on the shores next to the slain mate. Such animals can probably not tolerate any hunting. Manatees and Dugongs, likewise, need strict protection.

Many large birds, including condors, eagles and large parrots such as macaws, have low reproductive rates. The Cuban Red Macaw (*Ara tricolor*), became extinct in 1885. If its breeding biology resembled other large macaws, it was long•lived, reaching an age up to 80 years, had only one or two chicks a year and did not breed every year. Scientists have recently discovered that even in an immense national park in Peru, wild macaws produce so few young that any losses in their numbers cause declines in their populations. This helps to explain why so many birds of prey and parrots are endangered. Passenger Pigeons were long•lived, laid only one egg, and may not have nested every year. Likewise, turtles and tortoises are long-lived, with at least one species, the Galapagos Tortoise (*Geochelone nigra*) documented as living to more than 165 years in captivity. Some shark species do not breed until the age of 20 years and produce only a few young.

4. Flightless birds and slow•moving animals are helpless in the face of hunting pressure and predation by introduced predators and humans. Unwary animals, such as many island species that have evolved in the absence of predators fall into this category. Flightless birds, such as the Great Auk, Great Elephant Bird, Dodo, many Pacific Island rails and tortoises, are among species that lack defenses or cannot quickly escape predators, human or other. In addition to being flightless, many extinct birds lacked defensive behavior or the instinct to hide in underbrush as a result of their having evolved in predator-free environments. Predators introduced into their habitats, as occurred on many islands, soon eliminated them. Even the thick shells of tortoises were not effective defenses against predators such as rats, who ate young tortoises, and humans easily captured these slow-moving animals. Although our attitudes are more humane toward these vulnerable animals today than hundreds of years ago, tortoises and sea turtles are still killed for trade or by vandals for sport. Some surviving flightless birds on islands have official protection and a better future than they had in previous centuries, while others do not.

5. Large animals have been vulnerable to overhunting since the Pleistocene Epoch. In recent centuries, whales were added to the list of large species unable to escape guns or harpoons. The largest lemur and bird species of Madagascar were killed off by the Malagasy immigrants thousands of years ago, as were many large flightless birds by the Maori when they first arrived in New Zealand. Large animals are often killed merely because they make large targets or for trophies for those who enjoy slaughtering animals. Animals of large size require considerable amounts of habitat and are, therefore, naturally more rare than species with smaller habitat requirements. When human populations rise and wilderness is replaced with towns and industry, large animals are the first to disappear, due either to loss of habitat and prey or because they are killed as potential threats. Most of the largest mammals on Earth are now on the endangered list of the *2000 IUCN Red List*, including both species of elephants, all the rhinoceros species, and many large antelope and big cats such as the Tiger, Cheetah, Leopard and Lion. They have declined from hunting or persecution and are being crowded out of their habitats by human activities. Large animals are often keystone species at the top of their food chains or play important roles in ecosystems. Their absence is indicative of damaged or incomplete ecosystems. Elephants are important in spreading seeds of many plants through their dung, and large predators play a major role in the health and physical characteristics of their prey. The African savannahs without Lions, Leopards and Cheetahs would soon be overpopulated and overgrazed by their numerous prey species. The Elk of Yellowstone National Park became overpopulated in the absence of the Gray Wolf, and grazed certain plants so

heavily that some bird species and other wildlife disappeared and certain tree species became rare. In spite of the wolves™ importance to ecosystems, they are killed with impunity by livestock owners and others who consider them threats.

6. Wild animals and plants which have a value as food, pets, ceremonial objects or marketable products to humans are prime candidates for extinction. The list of animals that have been hunted to extinction for food is long. Within the past 400 years, many large land tortoises, the Great Elephant Bird, moas, Steller's Sea Cow, Auroch and Quagga were all extinguished by hunting for food. The unique Huia bird of New Zealand had plumes that were sold for large sums, helping to drive its limited population to extinction. Hawaiian songbirds were hunted to extinction for their colorful feathers, which were used in ceremonial headdresses and capes. Within the past decade, trade has increased as a threat to wildlife with the rise in Asian economies. This has fueled the Traditional Medicine markets, which consume vast numbers of animals, threatening many of them. The vacuuming of the seas by commercial fisheries has resulted in depletions and endangerments. The once abundant sturgeon of the Caspian Sea, for example, sources of Beluga and other expensive caviar, are now critically endangered as a result of unrestricted fishing and poaching for the luxury gourmet market. The bushmeat markets of West and Central Africa sell tons of slaughtered monkeys, forest antelope, Chimpanzees, Gorillas and other wildlife, devastating species whose tropical forest habitats are being logged. Hunting for food is also a major threat as firearms become available to native peoples who once used primitive weapons. Southeast Asian wildlife is under siege by people who once hunted only for their own purposes but now find that a wide range of wildlife can be sold in local meat markets or for Traditional Medicine. They set nooses and traps, killing rare monkeys and antelope, birds, snakes, turtles and tortoises, pangolins and lorises, clearing out the forests of wildlife. The pet trade is driving many colorful tropical birds, reptiles and primates to endangered status. Luxury goods, such as high-priced reptile products, provide an incentive to hunt--legally or illegally--lizards, crocodiles and snakes for this market, endangering many species. Trophy hunting of endangered species by wealthy hunters is a major threat to a growing number of animals, especially since the largest specimens are killed; these are the ones that should be left to breed. The higher the value of the animal or product, the greater the threat to that species.

7. Altruism, or the unselfish care for members of one's own species, highly admired as a human trait, has been fatal to many animals--the Passenger Pigeon, Dodo, Carolina Parakeet and Steller's Sea Cow, for example. In their evolutionary history, this behavior served to preserve bonds between animals and to frighten off predators. When confronted with guns or other weapons wielded by humans, however, animals that come to the aid of fallen mates or flockmates can be easily killed themselves. Refusal to leave their wounded fellows hastened the extinction of many species. Endangered species with these traits include wolves, gorillas, whales and elephants.

8. Species breeding in colonies or requiring large numbers of their own kind for protection, to locate food sources or for other means of survival, are vulnerable to extinction. The Passenger Pigeon was a colonial nesting bird and could only survive among large numbers of its own species, flocking and seeking food sources over large areas. When flocks were fragmented, these separated populations declined to critically low levels, even though their total numbers may have been in the tens of thousands. The Passenger Pigeon may have become critically endangered as soon as its migrations, feeding and nesting behavior were interrupted, even though it appeared to observers at the time to be plentiful. These pigeons had longevity of several decades, and failure to reproduce would take some time to be noticed in the overall population. But when there is little or no introduction of young into a population over a period, it can suddenly crash with little warning, as the Passenger Pigeons did. Wild parrots tend to feed, roost and spend their time preening and in courtship as a flock. For some species, these flocks number in the thousands of birds. When netted or caught by various means for the pet trade, which threatens a large number of species, their flocks are broken up and they are no longer able to function as a group. Their breeding is curtailed or stopped altogether, and they may no longer fly in groups seeking fruiting trees or mineral licks when they fear being captured. Flamingos require large numbers of their own kind for feeding, flocking, migrations and breeding, and their populations crash if any of their survival requirements are not met.

Many species of birds have breeding strategies in which male birds will not breed unless they are able to display

courtship behavior in the company of other males, vying for the approval of females. Birds of paradise, cocks•of•the•rock in South America, prairie chickens and grouse of North America are among birds that display for the benefit of females, who choose among them. Such birds require specific conditions to breed, and habitat alterations, reductions in their populations or hunting pressure that keeps them from exposing themselves in the open can prevent their breeding.

Mammals, reptiles and amphibians also have male contests of strength, agility or other mark of superiority of species. Wild sheep and deer vie for females by head butting and challenging one another. Many types of tropical frogs emerge during the breeding season to form groups that display to one another for the benefit of females. Male Plowshare Tortoises joust with one another in attempts to upend the rival and will not breed if only a single male and a female are placed together. Without rivals for competitions, male breeding behavior may not be triggered, preventing reproduction.

Zoos and zoologists are only beginning to understand some of the instinctive responses necessary for breeding. Our traditional concept that a compatible pair of animals will reproduce is often incorrect, and populations of animals must not be allowed to be so reduced that their natural breeding behavior and other survival needs are not met.

Thus, while population numbers can provide important information about the status of a species, without additional information, such as the traits mentioned above, the data can be extremely misleading and inapplicable. The number of individuals surviving in a species, when known, must also be placed into a context greater than their rate of decline and habitat status. Unless the entire breeding biology, behavior and other aspects of species' survival needs are taken into account, extinction cannot be predicted, or status properly evaluated.

Some species now extinct suffered from several of the above factors, which hastened their extinction. The Passenger Pigeon, for example, required enormous amounts of food, mainly from nut-bearing trees in old-growth forests, and was relatively long•lived, killed for food and commercial sale, and lived colonially. Elephants and manatees are among endangered species with many vulnerable traits, including large size, altruism, slow-reproduction, low natural mortality and longevity. They are also slow-moving and valuable in trade and as food sources.

These traits indicate only vulnerability to extinction caused by humans, not species likely to become extinct through natural selection. Sea turtles, for example, have lived on Earth for more than 200 million years. By any standard, they are a superbly successful, adaptable species that, prior to recent exploitation, showed no signs of decline. Their vulnerability lies in their inability to flee rapidly in the water or while laying eggs onshore when preyed on by humans.

Many endemic species occupy very limited habitats and have small populations but have not been listed as threatened if their environments or populations have not declined. The majority of these species have prospered for thousands of years in stable environments, and only the intrusion of human-related activities and domestic animals upset this equilibrium. Such species are extremely vulnerable to even minor habitat destruction or hunting pressure and should be carefully monitored for losses in their populations.

Because of human technology and weaponry, all animals have become vulnerable. Animals that for thousands of years used natural camouflage, stealth and intelligence to escape from natural predators, have become easy prey for human hunters and fishermen. Predators, never in their evolutionary history preyed upon, now find themselves targeted by hunters, trappers and poisoners. Sonar locates fish schools and whales, and heat detectors and night-view binoculars observe animals in darkness. Cleverly constructed blinds hide hunters from view. Animal scents are used to lure wildlife, and hunters imitate animal sounds or use tape recordings of their calls to lure them to traps or within shooting range. Some hunters use the signals emitted by radio transmitters placed in wild animal collars by biologists for tracking, to hone in and pursue them to their deaths. Guns equipped with telescopic sights can fire at targets mile away, killing animals before they are even aware of the hunter. Other weapons include sophisticated traps, nets,

snares, guns, harpoon guns and high•speed vehicles and boats, with which people can run down, maim and kill even the swiftest and most intelligent animals. These devices give humans such an advantage that they render the natural protections animals have evolved over eons completely ineffective. Hunters are able to kill the fittest and strongest specimens through these means. In the process, we are changing the course of evolution from survival of the fittest to survival of animals that are tolerated by humans and those able to persist in an increasingly polluted, damaged and ecologically impoverished natural environment.

Those species whose populations have become greatly reduced are vulnerable to extinction through genetic impoverishment and inbreeding. Such species usually remain rare or gradually fade into extinction as fertility declines. The critical low level which results in extinction is different with each species and cannot be predicted with certainty.

Just as the story of North America's lost species and environments is illustrative of many similar tragedies, the account below of the civil war in Rwanda and the former Zaire encapsulates the major threats to wildlife and the environment. It also makes abundantly clear that the survival of humans, animals and the environment are intrinsically linked. The influence of countries that contribute foreign aid to poor nations half a world away, and interfere in their politics, is another important element that can greatly affect the survival of wildlife and the natural world.

Human Tragedy and the Looting of Virunga's Treasures: Page 1

The mist•enshrouded Virunga Mountains of East Africa tower over dense highland vegetation. Far below, crystalline lakes ringed by marsh reeds glisten in the sun. Shy forest African Elephants walk along mountain paths in single file. Groups of endangered Mountain Gorillas (*Gorilla gorilla beringei*) feed in forest glades. Three hundred fifty of these magnificent animals, almost half their world population, reside here (Fisher 2001). The western edge of these mountains is protected in the vast 12,800•square•mile Virunga National Park, bordering western Rwanda. Some 766 species of birds reside here, more than are native to the United States and Canada combined. Iridescent sunbirds feed on the flowers of giant lobelias, and more than 200 species of mammals live in the park (Bonner 1994). Many of the species native to the park are found nowhere else on Earth. This ecological treasure is Africa's first national park, set aside in 1925. Virunga was closed to visitors other than scientists until very recently. In the 1970s, it became a World Heritage Site, a designation by the United Nations Educational, Scientific and Cultural Organization (UNESCO) for places deserving special recognition and protection.

In the early spring of 1994, political upheaval in the region caused a civil war that wreaked massive ecological damage and loss of wildlife in this natural paradise. Rival tribes in neighboring Rwanda clashed violently after the country's President was killed in an airplane crash caused by a rocket launch (Wright 2001). There were suspicions that his death had been arranged by his enemies. In an attempt to overthrow the minority-run Tutsi government, the Hutu majority began slaughtering Tutsi tribal members. Within months, more than 500,000 people, most of them Tutsis, were slaughtered in an appalling genocide that began with armed conflicts between army soldiers and rebels and accelerated to violence between neighbors. People of all ages were victims, many killed by slashes from machetes or battered to death with clubs. The Hutu failed in their attempt to overthrow the ruling Tutsi tribe and fled in panic west to neighboring Zaire, home of Virunga National Park.

Some 2 million Rwandan Hutu refugees flowed in a steady stream into eastern Zaire, just south of the park. Injured and starving, they crowded into camps where international aid organizations fed them and attempted to control cholera and other infectious diseases. Within days, scenes that might evoke visions of Dante's *Inferno* were televised by news organizations to viewers around the world. Gaunt, frantic people were seen scrambling frantically for food

supplies or lying listlessly in the final stages of starvation and disease. Estimates of total mortality from the war, starvation and disease exceeded 1 million people (Wright 2001). Many of the surviving refugees were afraid to return to Rwanda and remained in the refugee camps or built settlements on hills near Virunga National Park. To supply firewood to these 700,000 or more refugees, 30,000 people went into the rainforest each day, cutting down tens of thousands of trees (Bonner 1994). Rwandan soldiers and others began a thriving business selling firewood throughout the refugee camps. By November 1994, 112 square miles of the park had become partly or completely deforested, and little was done by Zairean troops or park authorities to curb the destruction (Bonner 1994). One forest ranger said, "Trees used to block the views everywhere. Now I see hills I didn't even know existed." An estimated 230 truckloads of trees left the park every day (Salopek 1995).

In December 1994, the World Heritage Committee placed Virunga National Park on a list of "World Heritage in Danger.fl Along with the forest cutting, park wildlife was killed for food by both refugees and Zairean soldiers, who had gone unpaid for months by the failing government. In mid-1995, more than 12,000 of Virunga National Park's Hippopotamuses (*Hippopotamus amphibius*) were killed for their meat and their ivory teeth, reportedly by Zairean soldiers using semiautomatic weapons. By late September 1995, there were still 700,000 Rwandan refugees camped near the park, removing 600 metric tons of firewood from the park each day (Lang 1995). Michel Leusch, Environmental Coordinator for the United Nations High Commissioner for Refugees in nearby Goma, said, "The quantity of biomass may be recovered in time, but some things, like rare plants and animals, have disappeared and cannot be replaced" (Lang 1995).

The government of Zaire began closing refugee camps in January 1996, with more than 1 million refugees still resident in 40 camps along the border with Rwanda. Another 700,000 Rwandan refugees stayed in camps in Tanzania and Burundi (McKinley 1996). Although millions of dollars were donated to supply food and medication, no aid funds were allocated for alternate fuel for these refugees, such as solar cookers and propane gas stoves that would have helped prevent the devastation of Virunga's forests. This highlights the need for an international ecological rescue fund that could ameliorate such tragedies, as well as safeguard wildlife from slaughter. In late 1996, Zairean troops attempted to force the last of the Rwandan refuges back into their country, causing open warfare to break out, and the last of the United Nations relief workers were forced to abandon the area. By mid-1997, hundreds of thousands of Rwandan Hutus had dispersed through the forests of Zaire, living off the land. Thousands of Hutus, jailed on their return to Rwanda, were placed on trial in an international tribunal in 2001 for their actions during the massacre.

Human Tragedy and the Looting of Virunga's Treasures: Page 2

A major underlying cause of Rwanda's civil war and the great suffering of its people is its uncontrolled population growth. In 1973, Rwanda's population reached 3,980,000 in a country whose total area is only 10,169 square miles--smaller than Maryland (Anon. 1975). This resulted in a ratio of 391 persons per square mile, one of the densest in the world. Populations continued to grow, however, and by 1992, they topped 8,206,000, with a density of 806 persons per square mile (Anon. 1994a). The country became increasingly crowded, as arable land became scarce. Competition for land had become intense. Much of Rwanda is eroded and barren, the thin tropical topsoil producing crops for only a few years after the forest has been cleared. Only 22 percent of the land remains forested (Wright 2001). Farmers slash and burn more forest for planting when land ceases to produce crops or grazing grasses. Steep, erodable slopes are being plowed right up to the limits of protected parks and reserves. The feuding between Hutu and Tutsi might have been peacefully settled if not for the extreme poverty and overpopulation. The average per capita income in 1999 was $720 per year (Wright 2001).

The war™s massacres killed almost 1 million people, leaving an estimated 7.2 million people by 2,000, according

to unofficial estimates (Wright 2001). Unless birth control becomes widely accepted in Rwanda, human populations will rise to an estimated 11 million people within a few decades. Some experts believe that nearly 22 million people will occupy Rwanda by 2020 (Anon. 1994a). By the latter estimate, there will be 2,163 persons per square mile in Rwanda, far more than its land can support. By contrast, the population density in the United States in 2000 was 76 persons per square mile, and Canada's, 8 persons per square mile (Wright 2001).

Human Tragedy and the Looting of Virunga's Treasures: Page 3

The effects of burgeoning human populations on wildlife and the once magnificent forests that covered the region have been tragic. Long before the forests of the Virunga Mountains became divided into the separate countries of Zaire, Rwanda and Uganda, and before the forests were replaced by agriculture in the latter two countries, thousands of Mountain Gorillas inhabited the region. As human populations rose, Gorillas declined to their present endangered status. These peaceful primates wander in the forest throughout most of the daylight hours, feeding on the luxuriant vegetation. As the largest and most powerful of all primates, the Gorilla male has an enormous chest, 20 inches across and up to 5.7 feet (1.75 meters) in circumference. He weighs up to 605 pounds, while females are much smaller, about half the weight of the male (Nowak 1999). The Mountain Gorillas' forests can become quite cold at night, and to adapt, they have developed longer, thicker hair than the Lowland and other races of Gorillas.

Gorillas travel in family groups led by silverbacks, named for the whitish-gray hair on their backs. These are the strongest and largest males, usually more than 20 years old, who guide and protect the band. Males compete for this role as soon as they are teenagers. Silverbacks father the babies in the family group, although sometimes females mate with "outside" males. These groups often travel long distances to locate fruiting trees and edible plants and tubers. Almost entirely vegetarian, Gorillas eat 40 pounds of food a day, feeding on 70 or more species of leaves, bark, fruit, roots, fungi, flowers and bamboo. They rarely drink water, obtaining moisture from the dew-laden plants, and the only animal matter they consume consists of insects. Gorillas consider army ants a delicacy and occasionally eat grubs and other insects.

In Rwanda's north, contiguous to Virunga National Park, where about 250 Mountain Gorillas survive, Volcanoes National Park, a 48-square-mile forest reserve, is home to about 100 Mountain Gorillas (Fisher 2001). The latter forest was once much larger, but the needs of agriculture had greater priority, and some 65 square miles were carved out of the park, squeezing the Gorillas into a fraction of their original range in the country.

Human Tragedy and the Looting of Virunga's Treasures: Page 4

In neighboring Uganda, the small Mgahinga Gorilla National Park, a 34-square-kilometer reserve, protects 40 more Mountain Gorillas. Some 25 kilometers north is a beautiful cloud forest, Bwindi Impenetrable Forest National Park, covering 330 square kilometers, in an area of high biological diversity (Butynski and Kalina 1993). This forest has the greatest number of trees of any in East Africa and so many endemic plants that it has been selected by the IUCN Plants Programme as one of Africa's most important forests (Butynski and Kalina 1993). Birds, butterflies, amphibians and reptiles found nowhere else inhabit the Bwindi Impenetrable Forest. It also protects a population of 300 Mountain Gorillas who have smaller bodies, longer limbs, hands and feet than those of Zaire: Their skulls and trunks differ also, and they are somewhat different genetically from other populations (Croke 1995, Drewes 1997). Scientists are now considering naming these Gorillas a separate subspecies. Destruction of forest and other habitats outside Uganda's and Rwanda's parks is extensive, making these last natural areas crucial to the survival of the

Mountain Gorillas.

Uganda's decades of chaos under President Idi Amin decimated the wildlife of this lovely country bordering Lake Victoria. Murchison Falls and Queen Elizabeth National Park once had magnificent concentrations of elephants, hippos and other large mammals, but by 1997, little remained, having been slaughtered by rebel groups or refugees from neighboring countries (Drewes 1997). Uganda's Ministry of Tourism, Wildlife and Antiquities conducted an aerial survey of Uganda's remote northern regions to determine whether some wildlife might remain to restock other areas, but they found "absolutely nothing" (Drewes 1997). Uganda has recently made a commitment to restore its wildlife and has reintroduced many large ungulates, trucked in from Kenya, into its national parks.

Human Tragedy and the Looting of Virunga's Treasures: Page 5

Although Gorillas share more than 98 percent of human genes, making them, along with the two species of chimpanzees, our closest relatives, until the 1960s, they remained mysterious, threatening creatures in the view of the public, depicted as monsters in movies. During the 19th century, explorers and hunters killed them as ferocious symbols of savagery. The work of American biologists Dr. George Schaller and, later, Dian Fossey, who entered the forests of the Mountain Gorillas as observers and researchers, changed this image forever. Films and books of the National Geographic Society and others revealed the gentleness and intelligence of these magnificent primates to people around the world, and gradually, conservation programs began to replace trophy hunting.

Schaller, who began his research in the 1960s in Virunga National Park, wrote about these primates in *The Mountain Gorilla*, published in 1963 by the University of Chicago Press, and a popular version, *The Year of the Gorilla*, in 1964. He provided the first scientific observations of these remarkable animals and recalled his encounters with them in a 1995 *National Geographic* article:

> *I approached them with empathy and respect, wanting nothing from them but peace and proximity. And they accepted my presence with an astounding generosity of spirit. The recent decades have been a turning point, indeed a revolution, in our relationship with animals. Humans have begun to overcome cross-species barriers, achieving intimacy with humpback whales, chimpanzees, lions, mountain sheep, wolves. The gorillas of popular image were a fantasy . . . No one who looks into a gorilla's eyes--intelligent, gentle, vulnerable--can remain unchanged, for the gap between ape and human vanishes; we know that the gorilla still lives* within us. Do gorillas also recognize this ancient connection? (Schaller 1995).

In the 1960s, Virunga National Park sheltered the largest population of Mountain Gorillas, numbering some 450. They declined to 275 by the 1970s, and to 250 by 1981, a result of poaching. The Mountain Gorilla Project, begun in 1978 by Schaller and a consortium of conservation organizations, including the New York Zoological Society and the African Wildlife Foundation, sought to stop the Gorilla's decline toward extinction. Funding went toward anti-poaching programs, education of local people, and ecotours (Schaller 1995). With non-threatening visitors to the park, many Gorillas grew tame. They were given names by park rangers and scientists and became familiar to tourists who came from around the world to see them. The conservation program and ecotourism succeeded in nearly eliminating poaching, and Virunga's Gorillas increased to 320 by the late 1980s (Schaller 1995). The Gorilla Project also operated in Uganda, where the government ejected 2,000 farmers from 3,500 acres, offering to compensate them with 10 percent of the revenue from tourists who come to see the gorillas (Salopek 1995).

Human Tragedy and the Looting of Virunga's Treasures: Page 6

Fossey's early research was sponsored by the famed anthropologist Louis Leakey, who had earlier convinced Jane Goodall to go to Tanzania to study Chimpanzees (*Pan troglodytes*). Both researchers changed forever our views of these fellow primates. Fossey began her research in the 1970s in the mountains of Rwanda, making friends with a family of Mountain Gorillas. The silverback male of this troop, whom she named Digit, became so trusting that he was filmed by the National Geographic Society gingerly taking her pen and then her notebook, returning them to her, and then lying down and going to sleep by her side (see Video--Mammals). These immensely strong animals never harmed any of the thousands of people, from rangers and scientists to tourists, who visited the reserve over several decades. When they felt their family was threatened, they made shows of aggression, pounding their chests or rushing headlong through the bushes toward the potential threat, whether human or another male Gorilla, but stopping short of physical blows. Humans, however, misinterpreted their displays, shooting and killing many silverbacks.

Commercialization of Gorillas--the high value of their young in the exotic pet trade and the many thousands of dollars offered by zoos to obtain illegally captured specimens--has presented a major threat to the species for many decades. Local people enter parks and reserves to shoot adults guarding the young, remove the animals™ heads and hands, and grab the traumatized babies. Other Gorillas are killed accidentally by illegal wire snares set in the parks for antelope and small mammals. Although efforts had been made in many parks to stop the killing of Gorillas, not until December 1977 did international attention become focused on this grisly and cruel activity. Six Rwandans, with their hunting dogs, entered the reserve armed with spears to kill Gorillas. They encountered Digit, who boldly rushed at them, pounding his chest. This allowed his family to escape, but cost him his life. The Rwandans speared him five times until he died, and then cut off his head. Gruesome photos of Digit's headless body received enormous publicity in the media, causing shock and dismay in millions of people who had seen photos of him in gentle communication with Fossey, as well as films produced by the National Geographic Society about her research. His death served to inspire both compassion and renewed conservation efforts for these beleaguered primates.

Fossey's Karisoke Research Center expanded, and thousands of tourists came to glimpse the Mountain Gorillas in their forest home. The threat of poachers remained, however, and Fossey, after a fervent campaign to prevent further Gorilla killings, was herself killed. Her murder has never been conclusively solved, but Rwandans are the major suspects. She is buried in the reserve next to the grave of Digit. Fossey recounted her experiences with Gorillas in a book, *Gorillas in the Mist*, which was later made into a commercial film of the same title. The silverback star of this film was named Mrithi. Not long after the film was made, in May 1992, he, too, was shot and killed by Rwandan soldiers, surrounded by his family of 11. Even after being wounded, he managed to drag himself some 6 feet toward his attackers before collapsing and dying.

Human Tragedy and the Looting of Virunga's Treasures: Page 7

During the 1980s, the country of Rwanda had adopted Mountain Gorillas as an international symbol of wildlife protection during the 1980s, and when civil war broke out in the spring of 1994, both sides promised to spare them--promises that were not kept. In April 1994, the Rwandan civil war forced the staff of biologists at the Karisoke Research Center to depart (Perlez 1994). By early July, most of the wardens of the Rwandan Office of Tourism and Volcanoes National Park fled also, but a few dedicated guards refused to leave the Gorillas and remained. Soon after, Rwandan soldiers entered the park and ransacked the offices, destroying records and books and throwing computers out windows but, fortunately, sparing the lives of the guards and the Gorillas. The war claimed at least one Gorilla

that year, however, when a male named Mkono was killed by a buried land mine (Tuxill 1997).

The staff of Volcanoes National Park was devastated by the war. Two-thirds of Rwanda's park employees died or remained in exile after the war ended, and 48 of 50 vehicles were destroyed (Salopek 1995). When surviving employees returned, many of them having been rescued from the masses of people living in refugee camps, with the help of United Nations personnel, they were delighted to see the Mountain Gorillas again. Nshogoza, a park employee who has spent 18 of his 44 years at Karisoke and has known generations of Gorillas, told a *National Geographic* writer, "When I was a boy, I heard that gorillas were men who were very bad and who went to live in the forest. But the gorillas are better than us. They are peaceful. They have no tribes. When they fight, it is for a good reason. We cut one another with machetes for zero" (Salopek 1995). To honor these guards, the park received the $50,000 J. Paul Getty Wildlife Conservation Award in May 1996, the money to be managed by the International Gorilla Conservation Program. Some was spent detecting and defusing more than 75 mines and booby traps left after the war, and other funds restored tourism in the park.

The Mountain Gorillas of Virunga National Park had been safe for a decade, but in 1995, Rwandan refugees, probably members of the routed army, entered their misty, forest home. In August and September 1995, three Gorillas--two silverbacks and one female--were found shot to death at point-blank range. One of these, named Marcel by the park scientists, was the most popular of Virunga's Gorillas, totally tame and gentle. He was so habituated to tourists that they could approach within a few feet of him, and hundreds of films and photos had been taken of him over the years. The bodies of Marcel and his mate were found sprawled out on the ground, full of bullet holes. "If someone comes in with a gun, the gorillas won't move out of the way," said Popol Verhoestraete, a field officer for the conservation program (Lang 1995). The killers left the bodies intact. These two Gorillas died trying to save their baby from poachers, who allegedly planned to sell him to a zoo. The park guards finally located this young Gorilla and seized him from the poachers, who were arrested. They carried the baby, who had become terrified and disoriented, in a small cage back to the family group. Not knowing if the frightened young Gorilla could survive without his parents, they released him, prepared to recapture him if things did not go well. After hesitating, he heard the sounds of his family and ran to join them. The leaderless and traumatized family group moved off into the forest.

Human Tragedy and the Looting of Virunga's Treasures: Page 8

Illegal snares have been threatening wildlife in these parks for generations. In the 1960s, Schaller saw two Gorillas in a group of 11 that had each lost one of their hands to snares (Schaller 1995). In Virunga National Park in mid-1995, a young male Gorilla was seen with a wire snare wrapped tightly around his foot, cutting off circulation, which threatened his life with septicemia (Salopek 1995). Just as the guards were preparing to capture him to remove the snare, they saw a huge male silverback watching over him. They waited until the right moment and darted the young Gorilla with a tranquilizer, taking him to a local veterinarian, who saved the Gorilla™s foot (Salopek 1995).

In another snare incident in 1995, a very young female Gorilla was caught by the wrist in a snare set by Rwandans who entered Virunga to trap forest antelope. A film by Bruce Davidson, "Mountain Gorilla," shown on the fiNational Geographic Explorer" television series (September 14, 1996), chronicled the trauma of this tiny Gorilla, who struggled in vain to free herself, crying out and screaming in fear and pain. The park rangers thought that she might have been in the snare, which was tied to a tree, at least 24 hours before they discovered her. She was surrounded by her family, but her relatives could not bite through the snare because it was made of strong nylon cord from food sacks donated to the refugees. The silverback male, Ndingutse, tried again and again to free the baby, and her mother held her to comfort her screams, but there was nothing they could do to release her. Finally, the park guards, who had been standing nearby, were able to approach when Ndingutse moved away for a moment, and cut the cord. She escaped, but faced the threat of becoming snared again, and the cord remained around her wrist, a threat to her circulation as

she grew.

The snares are usually attached to bamboo poles, bent over to spring when set off. Davidson filmed Ndingutse's brother, a 7-year old named Luwawa, in an extremely intelligent and protective reaction to a snare he encountered. When Luwawa saw the snare, he circled it, obviously aware of what it was. Waiting for the rest of his family to arrive and witness the act, he reached over and snapped the pole like a twig, avoiding the noose and disarming it. Against guns, he had no defense, however. Soon after, Luwawa was found shot dead on the slopes of Virunga National Park. His brother Salama had been killed months earlier. Only his bones and skull, picked clean of meat, remained when park rangers found him. The slaughter of these silverbacks traumatized the five to 10 females in their groups and left the babies and young without a strong male to protect them. They became shy and confused, hiding from humans, and even other Gorillas. In 1996, another two Mountain Gorillas were killed, bringing the toll for the previous 17 months to 10, causing havoc and psychological trauma in the families left behind and irreparable genetic damage to these highly endangered animals. In neighboring Uganda, more of these gentle Gorillas died--four adults in Bwindi Impenetrable Forest were speared to death by poachers in 1995 (Salopek 1995). The expulsion of farmers to enlarge the park for Gorillas caused great resentment, and perhaps precipitated this carnage. Tourists who came to see the Mountain Gorillas in this new Bwindi National Park in March 1999 met disaster when Hutu rebels ambushed and killed eight people in one group. This was thought to be the end of Mountain Gorilla tourism in Uganda, but with increased protection of tourists, they are gradually returning. Poaching declined after the deaths of Gorillas and tourists, and by 2000, the Mountain Gorillas in the Virunga Mountains in both parks totaled 358 (Fisher 2001). Tourists coming to Rwanda's Volcanoes National Park are still in some danger when not in groups guarded by soldiers, however (Fisher 2001).

Human Tragedy and the Looting of Virunga's Treasures: Page 9

The fact that Gorillas are gentle, kind and intelligent beings makes these cruelties all the more horrific. Millions of people saw a television report on August 16, 1996, showing Binty, a female Lowland Gorilla at a Midwestern US zoo, saving a little boy who had fallen into the exhibit and was lying unconscious; she picked him up and carried him gently to a door where keepers entered, setting him down in front of it. People were overwhelmed by her act of good will, as well as by her quick reaction. Many viewers had no idea that Gorillas would want to help a human in need, nor that she would use such good judgment in rescuing the boy, who recovered completely.

Koko, a captive Lowland Gorilla taught American Sign Language by Francine Patterson, president of the Gorilla Foundation, has learned some 800 signs and uses descriptive, imaginative language in naming unfamiliar objects, such as "finger-bracelet" for ring. She also paints, and when asked what one of her more colorful creations (reproduced on page one of *The New York Times*) depicted, she signed "bird" (Boxer 1997). We are only beginning to learn about these primates, but without strong protection, they may soon become extinct in the wild at the hands of humans.

Human Tragedy and the Looting of Virunga's Treasures: Page 10

Many Africans have little respect for Gorillas. Hunters in Cameroon, when asked by researchers why they shoot Gorillas, replied "What's wrong with killing a Gorilla? They're fierce." One of the hunters told reporter Michael McRae that he was sure Gorillas were plentiful: "In Cameroon there are a million Gorillas. Three weeks ago, I saw sixty in one day. I shot three and then stopped . . . Why should I feel bad for a Gorilla? He is just a stupid animal" (McRae 1997). Education and an alternate source of income might change the opinions of these hunters. They have

the same views Westerners had before research studies and films introduced people to the true nature of these primates.

As far as their abundance, there are hardly a million Gorillas in Cameroon, in all of Africa or the world. Gorillas are declining toward extinction. Their total population is estimated at well under 100,000 and declining (McRae 1997). The Lowland Gorilla and Mountain Gorilla are considered separate species by the *2000 IUCN Red List*, and both are classified Endangered. The US Endangered Species Act considers Gorillas to be a single species (*Gorilla gorilla)* and lists them as Endangered. Likewise, CITES lists Gorillas as a single species on Appendix I. The species is officially protected from hunting throughout its range, but national legislation is almost never enforced. The Lowland Gorilla is declining rapidly as a result of logging, killing for the bushmeat trade, and possibly ebola disease. Adults are often killed to obtain babies, which are traded on the black market to zoos in many countries. Hundreds of Lowland Gorillas are being slaughtered in Cameroon and other parts of their range, causing immeasurable trauma and cruelty to their close-knit societies, as well as ecological harm. The Moabi tree, a very important species for its fruits, seed oil, bark and wood, produces enormous seeds that Gorillas disperse (Tuxill 1997). African Forest Elephants are also crucial to the survival of Moabi trees, spreading their seeds, and they, too, are threatened with extinction.

The bushmeat trade is wiping out many other species of wildlife in wide areas around African villages. People set wire snares throughout the forest, into which rare deer, antelope, primates, wild pigs and a variety of animals blunder, struggling for days in great pain until the trappers arrive to kill them with knives. Even apart from the cruelty and conservation issues, the bushmeat and pet trades are not even lucrative. People make only a hand-to-mouth living from them, selling rare apes for a few dollars to traders, and other animals for a few cents. They are killing off their wildlife heritage while remaining in poverty.

Local people receive almost no benefit from logging, which is permanently devastating the old-growth forests. Tourists do not want to visit logged-over areas which have a fraction of the wildlife of unlogged forests and, in the case of clearcutting, an ugly, barren landscape. Trophy hunting, which is increasing in rainforests of Africa because of lobbying by the Safari Club and other organizations, is further reducing the wildlife. These hunters kill the largest and rarest animals--the prime specimens that should be left to perpetuate the species--and cause wildlife to become frightened and shy.

Mountain Gorillas are not killed for the bushmeat trade, but are shot for their body parts. None exist in captivity. These endangered gorillas are monitored within Rwanda's Volcanoes National Park by numerous researchers of the Karisoke Research Center, run by the Dian Fossey Gorilla Fund International. They are conducting a variety of different projects studying breeding, genetics and other aspects of their lives. One researcher noted the extreme devotion the Gorillas have for one another. Amahoro, meaning Peace, a 14-year-old silverback in the park, became lethargic and could not keep up with the group (Williamson 2001). Another male became his constant companion, and sometimes two males helped him along. The International Gorilla Conservation Programme was contacted for veterinary assistance. A veterinarian arrived and examined Amahoro from a distance, because he was defended by two other males (Williamson 2001). The next day, he was barely able to move and began coughing; the troop gathered around him, chest-beating in anxiety (Williamson 2001). After calls to gorilla veterinarians in the United Kingdom and the United States, the veterinarian decided that his problem was an infection in need of antibiotic treatment, which was administered by dart; he recovered fully (Williamson 2001).

Because of the international importance of the Mountain Gorillas and their precarious status, researchers from the National Aeronautics and Space Administration (NASA) began scanning their habitat in August 1994 during a 10-day environmental space satellite mission (Anon. 1994b). Overlaying the NASA images with data collected from navigation satellites and standard topographical maps is now providing an extremely detailed overview of the Mountain Gorilla's habitat. The habitat now protected totals only 285 square miles, not a large area for the 658 remaining Mountain Gorillas.

One wonders what their lives were like thousands of years ago when they roamed over vast, montane forests

undisturbed. They may have shown behavior that has disappeared under these new conditions. During some parts of the year, they might have frequented the lowlands, feeding on trees or other vegetation that has long ago disappeared, replaced by farmer's fields. It is possible that they are not receiving adequate nutrition from the plants in their reduced habitat. Their restricted ranges may be causing inbreeding. These Gorillas have suffered great psychological harm from the constant threat of death from hunters, never knowing when they may be confronted and killed. The loss of many family members to snares and shooting traumatized these sensitive and devoted primates.

Human Tragedy and the Looting of Virunga's Treasures: Page 11

Another important Gorilla habitat in southern Zaire was invaded by many of the 400,000 Rwandan refugees who fled to this area in 1994. This magnificent protected area--Kahuzi•Biega National Park--covers some 2,085 square miles (Jay 1994). It is also a World Heritage Site. The large mammals of this park were surveyed in 1994 by the Zairean Institute for the Conservation of Nature and the Wildlife Conservation Society (Jay 1994). Preliminary data indicated that the rare Grauer's Gorilla (*Gorilla gorilla graueri*), a subspecies of the Lowland Gorilla, was found in fairly large numbers--at least 1,000 animals (Jay 1994). Elephants were also numerous (Jay 1994), and the park has many rare birds (Collar *et al*. 1994). One camp of 50,000 refugees blocked a narrow corridor of forest that served as a migration route for elephants and lone male Gorillas between major sections of the park (Jay 1994). The Wildlife Conservation Society conducted a long-term study of the effects of hunting on wildlife in the park, supplemented by a 10-month United Nations probe, which released a report in April 2001 (Lauria 2001). Gorilla numbers have plummeted here also, killed for food and trophies. As ABC News filmed one of the few remaining Gorilla families in Kahuzi-Biega National Park during the summer of 2001, a male Silverback charged the camera crew. Only a decade ago, Gorillas were tame and securely protected in this area. The UN investigation determined that Rwandan forces and others have slaughtered all but two of 350 elephant families in the park for the illegal ivory trade (Lauria 2000). This poaching was part of an organized network of corruption now looting parks and natural areas in the renamed Democratic Republic of the Congo of diamonds, gold, timber and wildlife (Lauria 2001).

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In April 1995, a third natural area in Rwanda, Akagera National Park, became threatened when 700,000 cattle and 250,000 Tutsi herders moved 15 to 20 miles into the park (Lorch 1995). Because of a lack of arable land, Rwandans have sought out parks as the last remaining unoccupied territory. Akagera National Park, located on the eastern border of the country, has a wide variety of fragile habitats, from swamps and savannah to forest and hills, harboring gazelles, Giraffes, African Elephants and Leopards (Lorch 1995). Rwandan authorities did not exclude the herdsmen and their livestock but tried to convince them to cull their herds (Lorch 1995). In southern Rwanda's Nyungwe Forest, the Wildlife Conservation Society's colobus project, which protected groups of hundreds of these monkeys, was also devastated. In February 1995, investigators found that one-fourth of a 120-member colobus group had been killed during the war, many for their long fur, which was used in marriage rituals (Fine 1995). Researchers came upon animal snares and concluded that this national park would no longer be protected as such, but would become a multiple-use forest (Fine 1995).

Uganda's rare wildlife also incurred losses from Rwanda's war and Burundi's civil strife in a ripple effect. An extremely endangered bird of the Virunga Mountains, the Congo Bay Owl (*Phodilus prigoginei*), was recently rediscovered after being thought extinct. Not seen since 1951, it was seen in Uganda's Itombwe forest in mid-1996 by scientists from the Wildlife Conservation Society. A type of barn owl, the Bay Owl was previously known only from a specimen collected in Zaire's Kivu province in 1951 (BI 2000, Hart 1996). The owl is restricted to a small area of mixed rainforest and savannah near the Rwandan border (BI 2000). Dr. John A. Hart, the zoologist who found the

bird, saw farmers clearing the surrounding forest to create new farmland; they had entered the area seeking refuge from the civil wars in neighboring Rwanda and Burundi (Hart 1996). Although the total population of the Bay Owl is not known, it is presumed to be extremely small, and its future survival is uncertain. This area has no protected status and the entire known habitat of the endangered Congo Bay Owl is being degraded by clearing for livestock grazing and farming (BI 2000).

Some of Rwanda's refugees fled to Tanzania as well. More than 535,000 Rwandans traveled south into that country, staying in refugee camps near the border until December 1996, when the Tanzanian government demanded that they return to Rwanda. Former Hutu soldiers, fearing possible imprisonment for war crimes, convinced many refugees to travel east instead, into the heart of Tanzania's Burigi National Reserve. Once there, they stripped vegetation, killed large numbers of animals, began planting crops, and caused an increase in violent crime in local villages (AP 1996). At this point, the Tanzanian army routed them forcibly, and a stream of refugees many miles long was pushed back into Rwanda.

By 2001, a state of anarchy prevailed in the region, with these countries still at war. A United Nations report concluded that business and military leaders from Uganda and Rwanda were looting forests and parks in the Democratic Republic of the Congo for natural resources and meat (Lauria 2001). The New York-based International Rescue Committee reported in May 2001 that an estimated 2.5 million people have died as an indirect result of the previous three years of civil war in the Democratic Republic of the Congo (Salopek 2001). The fighting drove hundreds of thousands of people into the forests, where they lived off the land, dying of rampant disease and malnutrition in the rebel-held jungles (Salopek 2001). Gangs of poachers entered these rainforests, placing snares to capture elephants, Leopards, antelope, wild pigs, and monkeys for the bushmeat, fur and ivory markets in large cities. A camp of these poachers, many of whom come from neighboring countries, was encountered in the travels of Wildlife Conservation Society biologist Michael Fay. Fay and his group, including National Geographic Society filmmakers, came upon a sizeable camp with a very large Leopard skin stretched out on pegs, with hundreds of antelope and monkey bodies being cooked on open fires. Fay was so irate that he burned the entire camp and all the skins (shown on National Geographic Explorer, April 2001, entitled "Extreme Africa"). Although laws ban such killing, no game wardens patrol these forests, which were not part of a national park. Fay's intention in traveling across Central Africa, as described in *National Geographic* (Quammen 2001), was to show the world the great treasure being plundered by loggers and meat hunters before it is too late to save this large rainforest.

Human Tragedy and the Looting of Virunga's Treasures: Page 13

The future of wildlife in Rwanda, the Democratic Republic of the Congo and surrounding countries remains extremely uncertain. The region is a microcosm of struggles that may soon be commonplace as human populations continue to rise and compete for dwindling land and resources. Markets as far away as Europe and North America buy the timber, minerals and ivory that are being exploited here at the expense of the environment. At the present rates of loss, little wilderness or natural forest will remain anywhere in the world. The damage done to parks and reserves by tree cutting, clearing land, and killing native wildlife, especially for commercial purposes, devastates biodiversity and endangers species reliant on these refuges, which are often their last remaining habitats. The World Conservation Union issued a report in 2001 on the urgent need to protect the world's 17,000 large nature preserves from intrusion by poor farmers, who have nowhere else to go (Revkin 2001). Half of these preserves now have people cutting forests and tilling land in biological hotspots and areas with large numbers of endangered species (Revkin 2001). At least 900 million people earn less than $1 per day, and 630 million live in areas of high biological diversity, according to the report's author, Jeff McNeely (Revkin 2001). Organizations, such as Future Harvest, which co-authored the study, are attempting to help poor farmers by providing means to enrich soil through fertilizers and rotating crops to maintain corridors of undisturbed land as wildlife habitat, and to grow shade crops, such as coffee and cocoa, which maintain forests (Revkin 2001).

John Terborgh (1999), a Duke University scientist, chronicled massive destruction of parks by farmers, logging, livestock and squatters in *Requiem for Nature*. This book paints a gloomy picture of wanton neglect, insufficient funding and failure by governments to protect parks and reserves, many of which harbor endangered species and magnificent landscapes. In Peru, for example, national park officials in the capitol city were not even aware of the existence of the Cerros de Amotape National Park. When Terborgh visited the park, he found it had been logged by the army, and cattle grazed throughout. Yet this dry tropical forest is one of the most important centers for endemic plants and animals in the world (Terborgh 1999). Similar tragedies are occurring in Mexico, where logging trucks leave the spectacular montane Nevado de Colima National Park loaded with giant tree trunks, and cows consume all the new tree saplings from the few remaining old alder trees (Terborgh 1999).

In Colombia's Tayrona National Park, six park officials have been killed by rebels and squatters, drug traffickers, loggers and others, who are destroying it; 20 percent of Colombia's 22.2 million acres of parkland is in the hands of squatters or has been deeded to private interests (Terborgh 1999). Colombia has an extremely rich diversity of tropical birds and mammals, and much of the pressure on its parks is a result of the US market for drugs, which offers poor people a far greater income than they can earn through traditional farming. The Santa Marta region in Colombia's northeast has an extraordinary wealth of birds and other species found nowhere else. The endangered Santa Marta Parakeet (Pyrrhura viridicata); Santa Marta Sabrewing (*Campylopterus phainopeplus*), a hummingbird; and the Santa Marta Bush-tyrant (*Myiotheretes pernix*), a flycatcher, are among these (BI 2000). Conversion of forest to marijuana and coca plantations, compounded by US-sponsored government herbicide spraying programs to kill drug crops threaten these and other species of the area. Spraying contaminates the soil and water, and often the small aircraft destroy natural forest and traditional crops instead of the target drug crops. In March 2001, four governors from Colombian provinces protested the $1 billion US herbicide spraying program, saying it was jeopardizing the health and food supply of farmers (Marquis 2001). They asserted that the defoliation ruined food crops and alienated people from their national government, while not succeeding in curbing the narcotics trade (Marquis 2001). The Santa Marta region has already lost 85 percent of its forest habitat (BI 2000). Rebels have taken over much of the area, clearing forest for drug crops and killing members of native tribes, who have traditionally tried to protect the forest and wildlife.

The Democratic Republic of the Congo is in the early stages of a similar anarchy involving rebels and forest destruction. The late President Mobutu and other high officials acquired immense fortunes by siphoning off the nation's mineral and tax revenues and foreign aid funds. They purchased palaces and estates around the world and lived sumptuous lifestyles. Almost none of the revenue from the rich mineral industry went to public works, with the result that the majority of the country's people are illiterate and poorly fed and housed. Even the streets of the capital city are unpaved and littered with trash. Mobutu's personal fortune is estimated at $3 billion by some, and as much as $10 billion by others (Sachs and Rotberg 1997). This country had been a territory of Belgium, known as the Belgian Congo, prior to its independence in 1960. Over the next three decades, the United States and European nations supported Mobutu's regime, which became increasingly autocratic and corrupt. Any opposition was quickly suppressed. By the mid-1970s, the country neared financial ruin (French 1997). The United States, the International Monetary Fund and the African Development Bank supported Mobutu's regime until the end of his reign (Rotberg 1997). The funds were spent mainly for military purposes and for Mobutu's personal enrichment.

Strong opposition to his regime came from an opponent, Laurent Kabila, who drove Mobutu from office in 1997 and renamed the country, the fiDemocratic Republic of the Congo.fl Mobutu died September 7, 1997, in Morocco, where he had taken refuge. He left the country $14 billion in debt, a sum almost three times the country's gross national product (Sachs and Rotberg 1997). During the struggle among Mobutu's forces, Rwandans and Kabila™s soldiers in Virunga National Park, four Mountain Gorillas were killed, one silverback and three members of his family. The International Gorilla Conservation Program reported that these Gorillas, who were tame and accustomed to tourists in Virunga National Park, were shot in crossfire when Rwandans entered the park and encountered Kabila's soldiers. Kabila was assassinated in 2000, replaced by his son, who was educated in Tanzania. He has moderated some of his father's extreme programs and appears to want to end the conflicts that are dividing the countries of

Central and East Africa.

The new government plans to rebuild 50,000 kilometers (31,000 miles) of roads (Wallis 1998). Loggers supply local hunters with weapons, ammunition and a ready market for the meat of Gorilla, Chimpanzee and other protected and endangered species (Pearce 1995). In a growing trend, more and more Central and West African towns are becoming dependent on bushmeat. A study in the neighboring country of the Congo documented that a single town of 10,000 people consumed nearly 6 tons of wild animals every week (Counsell 1997). In Gabon, some 8 million pounds of bushmeat are sold annually, half in urban areas (Tuxill 1997). Recent research has determined that even selective logging has damaged ecosystems in tropical African rainforests, and hunting has eliminated keystone species, such as forest elephants, that spread the seeds of many forest trees (Counsell 1997). Logging also leads to uncontrolled hunting as roads open up wilderness areas.

The Democratic Republic of the Congo has major reserves of cobalt, copper, cadmium, diamonds, gold, and coltan, an extremely valuable material used in making cell phones and computer games. The mining of these resources has damaged large areas of forest as thousands of people vie for high-paying jobs. The mining is uncontrolled by the government, as deals are brokered between international corporations and rebel leaders or even with foreign governments, such as Rwanda, which controls the $250 million per year coltan trade.

Endangered Pygmy Chimpanzees, or Bonobos (*Pan paniscus*), are endemic to these forests in a relatively small portion of the Democratic Republic of the Congo, and their habitat is being decimated by loggers, who construct a maze of new roads (Kingdon 1997). Remarkably intelligent and peaceful, primatologists consider Bonobos to be unique in behavior and ecology; they represent a profoundly important example of evolution (De Waal 1997). Numbering only about 13,000 animals, they are declining and classified as Endangered by the IUCN. No major reserve has been set aside for them. Another rare animal of the region, the Bongo (*Tragelaphus eurycerus*), a beautiful, striped forest antelope, is listed as Endangered in the eastern part of its range in Kenya, and Near-Threatened in the Democratic Republic of the Congo, as logging operations have surrounded the boundaries of an important reserve for this species (Counsell 1997; Hilton-Taylor 2000).

Wildlife Conservation Society biologist Fay finished his 1,200-mile voyage through many unexplored regions of the Democratic Republic of the Congo and neighboring Gabon in the spring of 2001. He found Chimpanzees and Gorillas that had never seen humans and approached his group with curiosity, and other areas where these great apes were completely absent, perhaps as a result of ebola disease (Quammen 2001). Impenetrable swamps and miles of tangled shrub, giant trees alive with insects, birds and lizards, abundant signs of forest elephants and buffalo, networks of streams and spectacular vistas of vast waterfalls and distant mountains still exist in the region, yet loggers, gold miners, poachers and displaced people are increasing in number, destroying this wilderness bit by bit.

A sign of the future, should logging and bushmeat hunting continue, was a traumatized, orphaned monkey, tethered on a rope in a hunter's camp. Seen by Fay's group, its photograph appears on the cover of *National Geographic* (March 2001). This young Mandrill (*Mandrillus sphinx*) had perhaps witnessed the slaughter of its entire family and was now in a strange and abusive environment without its fellows. This species is threatened in the wild and listed as Vulnerable by the IUCN. Among the largest of all monkeys, Mandrills weigh up to 54 kilograms and live only in the rainforests of Cameroon, Equatorial Guinea, Gabon and the Democratic Republic of the Congo (Nowak 1999). The adult male has an extremely dramatic appearance, his face spectacularly marked with electric blue ridges beneath his eyes, set off by a bright red stripe that goes down the middle of his nose and covers a large, round nose patch surrounding his nostrils. His face is framed by a mane of grizzled, olive-brown fur. The female is a somewhat smaller and less flamboyant version of the male. These are the only primates that move about on the ground in very large groups, numbering up to 600 animals. They feed on a large variety of plants, roots, fungi, invertebrates and, occasionally vertebrates (Kingdon 1997). Their sole habitat--undisturbed, primary rainforest--is disappearing rapidly. They are intensively hunted in some areas for the male's shaggy mane, which is used for capes and headdresses (Nowak 1999).

Mandrills are also killed for bushmeat, which is their most immediate threat, according to biologist Jonathan Kingdon (1997). Mandrill meat is more highly valued in these markets than beef, and hunters employ dogs, guns, spotlights, deep-freezers and trucks to harvest them, especially in the Democratic Republic of the Congo and Gabon (Kingdon 1997). These magnificent primates may be important seed dispersers, yet research has only begun on their wild ecology. They may vanish from their once vast realm before their role in the African rainforest is understood.

These ecological and political crises were long in the making. Decades ago, international funds such as the World Bank could have developed environmentally friendly industries, such as ecotourism, in Rwanda, Uganda and Zaire, with a large percentage of the profits going to local people. Aid organizations could have funded or encouraged these nations to promote literacy and conservation education and to provide birth control education. Foreign aid to Zaire by the United States and European countries could have gone toward helping the people of that country achieve economic independence, while promoting environmental protection.

Human Tragedy and the Looting of Virunga's Treasures: Page 14

There is worldwide interest and concern for the survival and conservation of the Mountain Gorillas and other wildlife of the Democratic Republic of the Congo, Rwanda and Uganda and an enormous potential market for ecotourism in many parts of these countries that would benefit both the people and the wildlife. Mountain Gorillas have attracted $10 million in tourism revenues to Rwanda (Tuxill 1997). The forests of all three countries, as well as those to the west in Cameroon, the Ivory Coast, the Congo (as distinct from the new Democratic Republic of the Congo), and Gabon harbor many zoological curiosities that could attract tourists, such as enormous Goliath Frogs, largest of all frogs, now threatened from over-collecting and habitat loss. Beautiful Congo Peafowl (*Afropavo congenis*), the only pheasant species in Africa, are endemic to the Democratic Republic of the Congo, resident in the Kahuzi-Biega National Park and several other reserves (BI 2000). Threatened by hunting, these large, crested birds would be a big attraction for bird-watchers. Other unusual wildlife, such as tiny forest antelope less than 2 feet tall, inhabit these rainforests, where towering trees draped in mosses and orchids have crested eagles nesting in their crowns. At the forest floor, blizzards of butterflies drink at streamsides, while colorful lizards flit up tree trunks. One innovative approach to wilderness protection could acquaint people around the world with such natural treasures without their having to travel. It could also help local people with funding. It is the use of videocameras connected to satellites that record wildlife and landscapes for the Internet. Internet users pay small fees to tune into these videocameras and their websites. A large portion of the funds could be given to local people. This popular new technology has helped South African national parks with their expenses. Small cameras can be placed in extremely remote areas and can be operated on solar power. They have virtually no impact on the environment, unlike large numbers of ecotourists.

One method of protecting endangered forests, which play an important role in reducing global warming, is the US Initiative on Joint Implementation, which encourages public utility companies to invest voluntarily in forest conservation. Through the Carbon Sequestration Program, sizeable expanses of tropical forests, which absorb enormous amounts of carbon dioxide, are being protected. Wisconsin Electric Power Company, Detroit Edison, PacifiCorp and Cinergy donated $2.6 million in 1995 for a 15,035-acre forest in Belize, adjacent to the Rio Bravo Conservation and Management Area. American Electric Power in Indiana is cooperating with PacifiCorp and British Petroleum to protect 5 million acres of Bolivian forests from logging (Passell 1997). This approach protects large amounts of forest in a cost effective manner: the estimated cost of sequestering 1 ton of carbon this way is just 37 cents, less than 1 percent of most emissions-reducing technology, according to *The New York Times* (Passell 1997). General Motors has helped purchase 30,000 acres of forest in southeastern Brazil, home of the tiny Golden-lion Tamarin (*Leontopithecus rosalia*). More than 90 percent of this forest, known as the Atlantic Coastal Forest, has been destroyed, and it is one of the world's greatest centers of biodiversity (Mittermier *et al*. 1999). This program should be used in conjunction with reduction of emissions from power plants and vehicles--not as a substitute.

In another cooperative venture to save tropical rainforests, US chocolate makers are urging owners of small farms to grow cacao, a crop that is grown in the shade of large trees (Yoon 1998). A worldwide shortage of chocolate has resulted from the spread of diseases in large-scale cocoa plantations in tropical regions around the world. Such diseases do not spread or take root when crops are grown in smaller, shaded areas which have a natural diversity of plants and animals, including insect-eating birds and reptiles (Yoon 1998). With the world's sweetest tooth, the United States consumes 629,000 tons of chocolate per year, far outstripping its nearest competitor, Germany, where 285,000 tons are eaten annually, according to the International Cocoa Organization. The American Cocoa Research Institute, the Smithsonian Migratory Bird Center and various candy companies, including Mars, Cadbury, Nestle and Hershey, are all cooperating in strategies that promise to conserve tropical trees and wildlife, and grow cacao plants in ecological ways (Yoon 1998). Huge plantations of cacao in Brazil and elsewhere have lost as much as 80 percent of their crop to fungal and other diseases in recent years, diseases that often spread in large plantings of a single crop.

Scientists have long noted that birds are abundant in small forested cacao and organic coffee farms, and they are encouraging this new cooperation to protect tropical birds as well as the hundreds of species of North American and European birds that winter in tropical countries. Shade-grown, organic coffee is also helping to save rainforests. A trend away from traditional shade-grown coffee into new strains that are grown in the sun, has resulted in the clearing of millions of acres of rainforest to grow this coffee for markets such as the United States. To counter this trend, some organic companies, organizations and institutions, such as the Smithsonian, are taking a strong stand urging people to buy shade-grown coffee to protect rainforests and migratory birds from North America that winter in Latin American forests. This coffee is sold in many natural food markets and chains, such as Trader Joe's. The restaurants and coffeehouses, such as Starbucks, that still use sun-grown coffee should be encouraged to sell shade-grown coffee to help preserve forests and wildlife.

Debt-for-nature swaps can provide relief for countries saddled by debt from loans made by the World Bank and other international funds. Through these swaps, a portion of a nation's debt is paid by the donor, which may be a conservation organization or other entity, in exchange for the establishment of parks. These swaps have been undertaken in Madagascar and several other countries. A growing movement to convince donor countries to forgive these debts is being waged by conservation and human rights organizations. Should these debts be erased, much environmental degradation would be avoided, since many destructive programs are carried out solely to pay off debt. One such program, called "Avanca Brasil" or "Advance Brazil," envisions a massive development program in the Amazon Basin, crisscrossing the forest with roads and railroads and damming rivers to produce energy (EII 2001). A minimum of 28 percent of this great forest would be destroyed and, more likely, at least 42 percent (EII 2001). Just since 1995, 5 million acres of Amazon forest have been leveled for development (EII 2001). These forests, a major factor in preventing global warming through absorption of carbon dioxide, produce vast amounts of oxygen and harbor a large percentage of the world's biodiversity.

If no positive steps are taken, these last sizeable rainforests will be gone, and severe climatic and ecological harm will result. The great forests of Central Africa are also in the process of being destroyed. World-class national parks, such as Virunga, may be completely destroyed within a generation by illegal logging, squatters and bushmeat hunting.

Earth's Worth

Governments around the world grant logging or mining contracts on a daily basis. Thousand-year-old forests and wildernesses covering vast areas are bargained away in deals made between corporate representatives and government officials, often through bribery. The fates of the native wildlife and plants of these regions hinge on the type and level of exploitation. Wildlife, plants, and their habitats survive or die out as a result of decisions made by politicians, most

of whom have no understanding of the importance of preserving diversity and extensive areas of natural landscape. At the present rate of destruction, wilderness will soon be gone, carved up and exploited for commercial purposes or destroyed by settlers.

Earth's Worth: Page 1

Citizens of the wealthiest countries represent some 20 percent of the world's peoples, but consume 80 percent of the planet's resources. The high standards of living that are enjoyed in North America, Western Europe and Japan depend in large part on importation of low-priced raw materials from poor countries. International corporations have few laws restricting their activities, which are causing major damage to forests, rivers, lakes and other environments. Moreover, the market provided by Europe and North America and, most recently, by some countries in East Asia, encourages fast-paced exploitation. Many of the recent logging contracts signed in Africa, Russia and South America have been negotiated to repay debts incurred from loans from the International Monetary Fund, World Bank or other funds. These loans are often for the construction of dams, factories or mines that primarily benefit third parties, such as large corporations. To repay the loans on schedule, countries are pressured to exploit their natural resources, forests and minerals, which are sold at low prices. Such loans rarely help nations develop according to their avowed intention, but send poor countries into an ever escalating debt that requires more and more forest cutting and other exploitation for short-term gains.

The US government's foreign aid tends to encourage mega-projects that do not help the populations of developing countries. Development that is environmentally friendly, based on small-scale business or ecotourism, is of far greater value in helping people as well as preserving wildlife. The decades that have passed since the publication of E.F. Schumacher's 1973 book, *Small is Beautiful. Economics as if People Mattered*, have only validated the philosophy of helping people through small-scale grassroots programs. Economic development programs that respect both people and the environment by finding means through which people can be economically secure, maintain their culture and live in their ancestral regions without destruction to natural ecosystems, should be the model in the future. The concept of small-scale eco-development has been endorsed by various conservation organizations, and use of solar cookers, bio-gas and fertilizer from livestock manure, development of crafts and other small-scale industries, education on crop rotation and use of crops adapted to particular areas, preserving forests to prevent erosion and not living in flood plains are examples of this approach. A wide variety of organizations are carrying out such programs in many parts of the world. Such approaches are also needed in North America and Europe, where conservation education has failed to teach such basic principles, and government officials lack basic knowledge about the environment.

Earth's Worth: Page 2

Subsidies provide another disincentive to conservation. On a worldwide basis, governments spend $700 to $900 billion per year on subsidies that actually encourage the destruction of forests and other natural areas (Grossfeld

1997). In the United States, the taxpayer pays for road building in national forests to enable logging companies to enter wilderness areas. The Forest Service charges these companies a fraction of the retail value of these trees--sometimes $10 or less for a giant tree worth $25,000. Yet almost no subsidies or tax benefits are paid for the use of recycled materials, such as paper, that would save the cutting of thousands of trees. For this reason, it is cheaper in the United States and many other countries to cut forests for paper than recycle used paper, and to obtain minerals from mines rather than from recycled metals. To further the lack of logic of this situation, one US government department encourages environmental destruction through taxpayer dollars™ subsidies for logging and mining, while others spend public funds to clean up the pollution and preserve species that become endangered from these activities.

A coalition of 26 organizations compiled information on US subsidies that have negative effects on the environment, entitled "Green Scissors '98." It found that the United States spends $49 billion every five years on subsidies and environmentally destructive programs. The report recommended drastic slashing in these "polluter pork" programs to protect the environment and save taxpayers billions of dollars of misspent money each year. The Institute for Research on Public Expenditure in the Netherlands produced a report in 1997 entitled *Subsidizing Unsustainable Development: Undermining the Earth with Public Funds*. After a lengthy examination of subsidies around the world, which range from inexpensive irrigation water to free land for settlers and mining operations, this study concluded that subsidies are economically counterproductive and disastrous to the environment, resulting in deforestation, overfishing, polluting and other destructive activities (Crossette 1997a). Many species are endangered as a byproduct of these subsidies.

Earth's Worth: Page 3

The gross national product of a country is considered the major yardstick by which economic success is measured, and the natural world is traditionally valued in terms of the revenues it produces when exploited. This rigid and limited evaluation was recently examined and found lacking by a team of 13 ecologists, economists and geographers, who analyzed the monetary value of ecological systems to human society. They sought to place specific values on 17 types of environmental services that 11 ecosystems provide to humans each year (Stevens 1997b). Among these ecosystems were open oceans, estuaries, seagrass and algae beds, coral reefs, tropical and temperate forests, grasslands and rangelands, tidal marshes and mangroves, wetlands, lakes and rivers (Stevens 1997b).

In a report published in the scientific journal *Nature*, these specialists estimated the total global value of these ecosystems and their production at $16 trillion to $54 trillion per year, with $33 trillion the most likely figure; by contrast, the gross national product (all the goods and services produced by the world's peoples each year) was estimated at a mere $18 trillion (Stevens 1997b). They rated the value of nature's climate regulation at $684 billion, natural raw materials at $721 billion, pollination by natural pollinators at $117 billion, recreation and ecotourism provided by nature at $815 billion, soil retention and formation at $53 billion, water supply at $1.7 trillion, and food production at $1.4 trillion. Thus, ecosystems such as forests, which provide several of these ecological services, such as climate regulation, ecotourism, soil retention and water supply, are worth far more left standing than cut as lumber for short-term profit. Wildlife performs services as well, including natural pollination, attraction of ecotourism and recreation such as bird-watching, and others such as seed dispersal and soil enrichment. The linkages between particular ecosystems and local economies were systematically analyzed in this study; for example, the Louisiana shrimp catch depends on wetlands as nurseries, and these wetlands also provide flood control and other services in their overall value (Stevens 1997b).

If the costs of destroying these ecosystems were computed when development was considered, such as the loss in flood control and water pollution filtration by wetlands, the researchers concluded that society would be more likely to protect them from destruction. They pointed out that when a wetland is filled in for a shopping center, the dollar value

of that habitat in preventing floods and cleansing water is not figured in, resulting in a gradual erosion of natural wealth (Stevens 1997b). The heavy rains that ravaged many parts of the world in 1997 and 1998, caused by El Nino's effect on the weather, produced floods and mudslides in areas where forests had been cut and wetlands filled. Hundreds of lives were lost, and property damage totaled billions of dollars. Areas with forest and extensive wetlands were hardly damaged. Some wetlands are being restored in the United States--river courses returned to natural curves, and flood plains protected from building, in the realization that the lost income from not developing these areas is more than compensated for by the protection from natural disaster they provide, which creates economic stability in developed areas located far from wetlands.

However important such economic analyses are in re-evaluating our destruction of ecosystems, preserving nature cannot be reduced to economic calculations. If this is the sole basis of conservation, it could lead to destructive manipulations in the environment designed to accommodate complex economic theories. The major lesson to be learned from these new ways of looking at Earth's use to humans is that we have grossly underestimated life-giving ecosystems and their wild fauna and flora. They have evolved over a period of millions of years, and we must respect and preserve them in as natural a state as possible.

Although people in the United States are far more aware of the ecological value of wetlands and forests, this seems to have had little effect on preserving such valuable ecosystems. Trees are still cleared on steep slopes and other fragile areas, for example. This causes landslides and mudslides and floods, resulting in destruction of homes, roads, farmland and other valuable assets, as well as siltation and pollution of waterways. Yet there is little thought given to banning this practice by law. The World Resources Institute in Washington, DC, has calculated that the loss of value from deforestation is four times as high as the value of the timber extracted, and the depletion of soils, forests and fisheries examined in this study resulted in a 25 to 30 percent reduction in potential economic growth (Stevens 1997b).

A 1997 collection of articles, *Nature's Services: Societal Dependence on Natural Ecosystems* (Island Press), edited by Dr. Gretchen C. Daily, a biologist at Stanford University, concludes that many ecosystems, once destroyed, are either irreplaceable or take thousands of years to replenish, such as ancient aquifers or old-growth forests. Daily concluded that we cannot afford to wait to act until we have disrupted the planet's life-support system beyond repair (Stevens 1997b). Some 20 scientists contributed to this book, including Dr. Norman Myers, author of many books on the value of wild plants to medicine and agriculture. He documented the multibillion-dollar insurance value that wild grains provide in disease resistance (Daily 1997). Katherine Ewel of the Forest Service discussed the lower cost of treating sewage in constructed wetlands, as compared to treatment plants, and Gary Nabhan and Stephen Buchmann found that wild pollinators save American farmers $1.6 billion annually (Daily 1997). This book's experts make a strong case for protecting environments in a natural state and provide evidence that we are only beginning to appreciate the complexity of these ecosystems. This can apply, for example, to commonly accepted mitigation rules used in US wetland-filling cases, in which a wetland is created for one that is destroyed. Ecologists consider that the natural wetland is far more complex and irreplaceable than the man-made one, and they should not be considered equal under the law.

Earth's Worth: Page 4

In the United States, many politicians and businessmen have opposed environmental and endangered species legislation on the grounds that these laws reduce the profits of commercial ventures. They propose that every developer whose project is blocked by such legislation should receive financial compensation from public funds. These businessmen calculated the value of their financial loss on the appraised value of their land, and added potential profits lost. In 2001, for example, farmers in California sued the Fish and Wildlife Service to compensate for water it lost when a water allotment was diverted for endangered salmon and smelt (Russell 2001). The court ruled in favor of

the farmers and ordered the government to pay them the value of the lost water, arguing that the government is constitutionally prohibited from taking property without paying for it (Russell 2001). This ruling could end in negating the effectiveness of habitat protection under the Endangered Species Act for lack of sufficient funding. Ecologically, farmers depriving endangered fish of habitat are impoverishing entire aquatic ecosystems and, in all probability, polluting waters with pesticides and other chemicals in the process. Yet if the value of maintaining the ecosystem in the San Francisco Bay area was calculated in terms of the millions saved in flood damage control, water purification, production of shrimp and other fish, the ecological values would far outweigh short-term commercial losses. If environmental protection laws were written in terms of ecological values, destroying natural ecosystems for the economic benefit of a few would not be allowed.

When the Northern Spotted Owl (*Strix occidentalis caurina*), native to old-growth forests in the Pacific Northwest, was listed as Threatened on the Endangered Species Act and large sections of its habitat protected, it became a focal point, polarizing pro-logging and anti-logging activists. Owl haters urged others to kill these birds, who were blamed for ending the logging industry, with bumper stickers such as "Kill an Owl, Save a Job." Such venom totally obscured the fact that the forests were being overcut and that logging jobs were destined to be cut anyway, as the last old-growth disappeared under the saw. A state in the heart of this owl's range, Oregon, found that decreasing logging ended in helping its economy; an influx of technological businesses provided better salaries than those paid for logging jobs (Egan 1994). The Governor of the state supported the logging restrictions as helping to maintain the overall quality of life in the state, preventing floods and attracting tourists, which are supplying another large segment of the state's revenues. Yet pro-business interests continue to fuel the fires, writing books which conclude that it is easy to understand why a landowner, having an eagle or Spotted Owl nesting, could be tempted to destroy a nest or even kill an endangered animal. Such people maintain that the owner of such land might be expected to destroy it by logging or development prior to designation of Critical Habitat for the species in order to be able to reap profits. The Northern Spotted Owl has, in fact, declined since it was listed on the Endangered Species Act, mainly as a result of Habitat Conservation Plans that have been detrimental to its populations, but also, very likely, illegal killing played a role.

One conservative critic of the Endangered Species Act noted that the Act "has undoubtedly caused the deliberate destruction of millions of other endangered plants and animals" (Jacoby 1998). This explains, according to the critic, why after 25 years, 97 percent of the endangered species list remains endangered (Jacoby 1998). If so many endangered animals are being killed deliberately, enforcement of the Act is urgently needed. Such attitudes are extremely detrimental to the survival of endangered species and should be addressed. Although many animals are being killed, the main reason these species remain endangered is a deteriorating environment and a half-hearted commitment on the part of the US government and the public to saving these threatened species.

A study of America's environmental laws and their effect on the economy was conducted by the nonprofit Institute for Southern Studies, a social policy research group. It concluded: "At the policy level, the choice is really not jobs versus the environment. The states that do the most to protect their natural resources also wind up with the strongest economies and best jobs" (Smothers 1994).

Earth's Worth: Page 5

Ecotourism and non-destructive recreational uses of nature are among the most valuable of all services nature provides, according to the study mentioned above, and many countries have seen dramatic rises in their revenues from tourism in recent years. In 1995, Botswana earned $100 million from tourism; South Africa reported $6 billion in tourism revenues. Kenya earned $452 million the same year, which paid the wages of 13 percent of its population. One tour company, the Conservation Corporation of Africa, or Conscorp, works out arrangements with local villages in which it promises to build schools and clinics near its lodges, employing many local people in the process. It also

buys seeds for farmers to plant vegetables to sell to its lodges and brings villagers from the area into the reserve to educate them about wildlife and ecotourism. Conscorp runs some 22 small--but expensive--lodges in Africa from Kenya to Zanzibar, none of which allows game hunting; its revenues topped $30 million in 1996. Costa Rica, one of the world's primary ecotourist countries, has set aside 25 percent of its land for conservation, and ecotourism draws 1 million visitors per year, who spent some $800 million in the country (CNN special: "What Price Nature?" March 2001). This industry continues to grow at a rate of 20 percent a year, with visitors coming to its cloud forests, tree canopy tours and beaches where sea turtles nest.

In terms of the value of animals, the income from exploitation is dramatically lower than that from ecotourism. African Elephants, for example, when killed for trophies, earn some $4,000 to $20,000 for governments in fees, and the tusks sell for an average of $2,000 apiece. From ecotourism, however, an East African elephant produces an estimated $1 million during its 60 years (Currey and Moore 1994). A 1989 analysis found that the viewing value of tourists who come to Kenya to see elephants is estimated at a minimum of $25 to $30 million per year (Brody 1994). Tourists come from around the world to see these massive animals, and the governments of most African countries place a higher value on live elephants than dead ones. Trophy hunting also kills off the big bull elephants, which are the main breeding animals, as well as large matriarchs, who play a crucial role in guiding and protecting herds. These are the very elephants tourists come to see.

Endangered species in the United States also draw many tourists who travel long distances to see Whooping Cranes in their wintering marshes in Aransas, Texas**;** Gray Wolves in Yellowstone National Park; and California Condors newly reintroduced near the Grand Canyon.

Whales are extremely valuable in ecotourism. They are becoming major money-earners to the increasing numbers of whale-watching tours worldwide. In 1992, 37 countries conducted whale watching tours, and the United States alone earned $260 million. Since then, whale-watching has grown in popularity. A study by the International Fund for Animal Welfare found that in 1998, revenues from whale-watching exceeded $1 billion, with 9 million people participating in 87 countries and 500 communities. By contrast, a single Minke Whale sells for about $100,000 (Talmadge 2000), a one-time profit from these long-lived animals that is far less than they would produce during their lifetimes. Yet wealthy countries, such as Norway and Japan, are still killing whales, catering to whalers, who form a tiny segment of their populations.

Bird- and wildlife-watching and feeding have become major industries in the United States. A Fish and Wildlife Service survey found that in 1991, Americans who watched, photographed and fed birds and other wildlife spent $18.1 billion (Blom 1997). The spending generated nearly $40 billion in total economic activity and supported 766,999 jobs (Blom 1997). Equipment sales for wildlife appreciation totaled $10.6 billion, followed by $7.5 billion spent on travel-related goods and services, and $1.5 billion on wild bird feed (Blom 1997). A 1996 survey found that while only 3 million people in the United States hunted migratory birds, 25 million Americans were considered avid bird-watchers who would drive a mile or more to observe or photograph birds, and 50 to 60 million people in the United States watch birds at their feeders.

The Fish and Wildlife Service found in a 1996 survey that wildlife watchers, fishers and hunters spent $100 billion on equipment, travel, and publications. When total economic profits were analyzed by the Fish and Wildlife Service in terms of hunters vs. bird-watchers, the bird-watchers spent some $14 billion on all aspects of bird-watching, while bird hunters spent $1.3 billion. *American Demographics* magazine estimated that an even greater amount, $18 billion, was spent by American birders on their hobby. In economic output, Ducks Unlimited, a hunting organization, estimated that bird hunting generated $3.6 billion, while non-consumptive use of birds earned $15.9 billion.

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Consumptive users of wildlife, such as hunters, make up a small minority of the public, approximately 14 million, or 5 percent, and fewer than 1 percent are trappers, yet these interests control state wildlife departments and heavily influence the Fish and Wildlife Service. The fees from hunting licenses fund the majority of state wildlife departments. These departments manage all wildlife within a state, in spite of the fact that only a small number are hunted or trapped, with the result that habitats are manipulated to benefit hunted animals, such as deer, by encouraging shrub and second-growth forest, while species needing old-growth forest, such as woodpeckers, decline as these forests are cut. Endangered species are conserved by state Natural Heritage Programs, but funding is often miniscule in comparison with the fees from hunting. Funding sources include income tax rebates, vanity license plate revenues and grants from general funds, but generally do not begin to fill the need for habitat acquisition, education and conservation programs and research. Greater funding is needed for these programs, perhaps through a small tax, such as the less than 1 percent sales tax in Missouri for wildlife and conservation programs. It generates more than $100 million annually. A tax for non-game and endangered species would provide major funding for these state programs, which fill an important role not played by federal Endangered Species Act programs.

The recent phenomenon of tropical forest ecotourism has produced other comparisons in revenues of exploitative vs. non-consumptive use of wildlife. Dr. Charles Munn, an ornithologist with the Wildlife Conservation Society is studying macaws in Peru's massive Manu National Park, which is the size of Massachusetts. He estimates that a wild macaw is worth $165,000 a year, based on revenues from the growing number of tourists who come to see these colorful, long-tailed parrots in spectacular flights (Munn 1992). A bird trapper receives only a few dollars for a wild macaw which, if sent to a pet store in Europe, might sell for $1,000. Income from the pet trade goes primarily to a small number of exporters, importers and retailers. It does not protect the habitat of the birds, nor does it pay for population surveys to prevent depletions. Moreover, from capture onward, these wild birds are treated very inhumanely, causing high rates of injury and mortality. The capture of wild birds for the pet trade is banned by the majority of the world's nations, but the few that continue it contribute to depletion of wild bird populations, smuggling, and their inhumane treatment (see Trade chapter).

Under Munn's calculations, the value of each macaw in the wild over the period of its life, which averages about 50 years or more, totals some $8,250,000--an enormous sum. This money flows into local economies of villages and towns near the park, local hotels, taxis, restaurants and other businesses. For many poor areas, such income provides much needed services and raises the standard of living. Tourist money is also spent in cities where visitors arrive, and constitutes a major portion of airlines' revenues. Manu National Park has been declared a Biosphere Reserve in recognition of its importance as a center of biodiversity. Its 7,000 square miles protect a large portion of Peru's tropical rainforest. Manu's ecotourism companies are considered models for sharing revenues with local people and protecting indigenous tribes (Munn 1994). These companies have tours geared toward viewing certain spectacular or endangered species, such as Giant Otters (*Pteroneura brasiliensis*) (Munn 1994).

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Although some abuses of the land have resulted from ecotourism, including large numbers of people who can overwhelm delicate habitats, these situations are rare and can be rectified. Ecotourism helps far more animals and habitats than it hurts and, often in an indirect way. An important byproduct of tourism is the protection it accords animals in the areas visited, especially outside national parks and reserves, where most wildlife is on the decline. The presence of tourists tends to deter poachers, and in a growing number of areas, revenues accrue to local people from tourists™ use of restaurants, gift shops, taxis and other businesses. This encourages residents to cooperate in protecting the wildlife and the environment. This applies as much to African savannahs, as to North America or Europe. The non-profit Eco-Tourism Society, located in North Bennington, Vermont, distributes information on responsible travel that does not result in ecological damage and respects local residents. It recommends that tours

share profits with residents.

Many conservation organizations now run ecotours and issue pamphlets, such as the National Audubon Society's guidelines for environmentally responsible travel, which describes dangers to specific habitats, such as coral reefs, and suggests non-intrusive viewing and tours that enhance local conservation. Trade in local wildlife is prohibited. The Wildlife Conservation Society has proposed that a fee from tourists be set aside for a land bank to fund national parks in Central America.

As ecotourism rises in its importance to national economies, whale-watchers, tropical forest visitors, coral reef divers and others will demand pristine environments with diverse wildlife. This will be a strong force in favor of passage of strict environmental laws around the world. Moreover, the value of wilderness increases as more and more tourists seek out undeveloped areas. Governments should no longer consider wilderness as wasteland, but as a precious commodity.

The economical arguments in favor of preserving the natural world are strong, but we should be equally motivated by our affinities for our fellow creatures and the natural world. Our ties with nature are very deep and span millions of years. Modern technology has made us forget the awe with which we once regarded the Earth and has encouraged a false sense of superiority and complacency.

Actions and Attitudes

Biologists, conservationists, government officials and many members of the public are regarding the rise in the number of extinctions and endangered species with great alarm. The United Nations has found that species and habitats are being lost at an "unprecedented rate" (Stevens 1997c). The need for effective action has never been greater. Fortunately, concurrent with the general deterioration of the environment and wildlife populations, programs for the preservation of rare species have mushroomed, along with a new compassion for animals. These programs address the status of a small number of species, and if expanded to include a far greater percentage of threatened species, the extinction rate would decline.

Some conservation efforts to preserve endangered species have had remarkable success, while others have had mixed results. The expenditure of large sums of money to save some endangered species has not automatically resulted in an increase in their numbers. It is a common misconception that endangered species, once accorded legal and habitat protection, will survive and increase in number. Unfortunately, many species have died out in spite of conservation measures on their behalf. Through examination of failed programs, fewer mistakes can be made in the future.

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The Javan Tiger (*Panthera tigris sondaica*), for example, was given legal protection and reserves in the 1920s and 1930s, yet it was poached to extinction. If a single facet of a conservation plan is lacking, faulty or unfunded, this can spell extinction for the animal or plant. A reserve for this Tiger was set aside too late, when it was nearly gone. As Indonesia's most heavily populated island, Java had little forested land left, and by 1972, only four or five Tigers survived (Matthiessen 1997). With a very limited population under constant threat from poachers and big game hunters, these Tigers needed intensive anti-poaching protection and biological surveys, which they never received. Without well-equipped and motivated park rangers, research and surveys, education of local people and the goal of conserving Tigers established as a major priority of the Indonesian government, there was no chance of saving these cats. The last Javan Tiger was seen in 1976 (Matthiessen 1997).

Since the 1970s, Tigers have experienced precipitous declines throughout their remaining Asian range. Killed for their "magical" bones and body parts, which are used for Traditional Medicine as well as for potions that are intended to impart virility and strength, these magnificent cats are snared, trapped, poisoned and shot in devastating numbers, estimated at a minimum of one Tiger per day of the fewer than 5,000 that survive. A Tiger is now worth at least $50,000 in Traditional Medicine, placing a price on the head of every wild Tiger. Many experts are predicting the Tigers™ extinction outside of zoos within a few years. One program, however, has shown success in stemming this decline. In Russia's Far East, strong anti-poaching programs and intensive research and survey projects have halted the decline of the largest subspecies, the magnificent Siberian Tiger. This work has been funded by outside organizations including the Global Survival Network, a Washington, DC, organization, and other groups.

Only about 250 Siberian Tigers survived in the wild in the early 1990s, and with 50 or more being killed by poachers each year, their future seemed dim. The Russian government, in economic chaos, was unable to pay wardens a reasonable salary. Many resorted to illegalities to take advantage of the high value of dead Tigers. The open border with China brought an influx of smugglers and traders offering bribes of $5,000 or more to wardens and poor villagers for killing a Tiger. With the infusion of some $750,000 from conservation organizations since 1993 and help from the US Fish and Wildlife Service, well-armed and well-paid wardens now patrol most of the Siberian Tiger's habitat in modern vehicles. Without this outside funding, which must be continued indefinitely, poaching would have extinguished the remaining wild Siberian Tigers. Biological research on these Tigers is being carried out by the Idaho-based Hornocker Wildlife Institute, along with Russian scientists. These studies have surveyed their populations and obtained the first estimate of their habitat needs which, for males, is at least 450 square miles. One female Siberian Tiger named Lena, being radio-tracked by these researchers, was killed by poachers. Her four young cubs would have starved to death, but they were located when signals were received from the still-operational radio collar, which had been cut off Lena's body and placed next to the cubs. The terrified and hungry cubs were taken into captivity, and the three survivors were sent to US zoos.

Siberian Tiger poaching is finally decreasing. Russian conservation groups are conducting educational programs for local people and investigating suspected poachers along with Russian government officials (GSN 1997). Recent population surveys indicate an increase in Siberian Tigers, and conservation plans are falling into place (Galster and Eliot 1999). The Tiger's prey of deer and wild boar has been heavily poached, and the plan calls for anti-poaching work to preserve these animals (GSN 1997). Tiger biologists have drawn up a plan for a huge sanctuary in the region, suggesting habitat corridors linking isolated Tiger populations, and proposing an end to clearcutting of forests (GSN 1997). Without urgent protective measures, this magnificent cat will disappear. (See Forests chapter for more on this Tiger and its habitat).

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For some endangered animals, CITES has been crucial in preventing their extinction. After a prolonged controversy, the African Elephant was upgraded from Appendix II to Appendix I in 1989, which effectively ended the ivory trade that resulted in the slaughter of these intelligent animals, the toll reaching almost 1 million animals for the 1970s and 1980s. The 1996 *IUCN Red List* classified the species as Endangered for the first time, upgraded from Vulnerable status in the 1994 *IUCN Red List*. This status was maintained in the *2000 IUCN Red List*. The ivory trade reduced these slow-reproducing animals, who have a single calf only once every five years, from 3 to 5 million in the 1930s and 1940s to only 300,000 to 500,000 today (Onishi 2001). The high price of ivory in the 1980s encouraged the poaching of elephants outside parks, and when these were killed off, poachers entered national parks, often armed with machine guns. Almost all the large bulls and most of the older females were killed for their tusks, leaving traumatized teenage elephants without leaders and protectors and orphaned infants who starved to death.

In the majority of African countries where elephants survive, they are zealously protected for their value in tourist revenue and for their ecological value as keystone species. Many officials of these countries have said that they do not want future generations to learn about elephants only through books. Yet several southern African countries--Namibia, Zimbabwe and Botswana--which stockpiled ivory from the 1980s trade and from culls carried out to limit elephants, succeeded in 1997 in convincing delegates at the CITES Conference to allow sale of 65 tons of this ivory to Japan. Japan's sponsorship of much of the costs of the 1997 Conference, which took place in Zimbabwe, paved the way for the decision. The President of Zimbabwe made personal requests to delegates to allow the sale. Although CITES authorities enacted controls on the conditions of the sale of this ivory, it was predicted that the decision would open the door to further killing of elephants and ivory smuggling. This proved correct. African Elephants began to be poached again during the late 1990s in Kenya, the Democratic Republic of the Congo and other countries. An elephant orphanage in Kenya received an unprecedented number of orphaned calves at this time. Their mothers had been killed for their ivory in national parks. Some of this ivory is sold locally, and much is smuggled out of Africa.

A large confiscation of tusks was made in Los Angeles in May 2001; these tusks, many of which were very small and obviously from young elephants, had been smuggled from Nigeria in hollowed-out furniture. This indicates that allowing some sale of ivory opens the door to unrestricted slaughter and smuggling that will place the species in a critical--and perhaps lethal--decline toward extinction. When ivory was allowed to be sold on a quota basis in the 1970s, this "regulated" trade failed completely to prevent unregulated slaughter as the price soared. In many parts of Africa, poachers are killing elephants for a trade that may be resuming. Ivory is openly sold in Cameroon, and in Burkina Faso, a West African country north of Ghana, where only 3,000 to 4,000 elephants remain, ivory traders are selling carvings and jewelry in the capital city (Onishi 2001). One trader even complained that sales had not recovered as a result of the 1989 ivory ban, with larger carvings taking months to sell because tourists are no longer as interested in buying ivory (Onishi 2001). When asked about the need to conserve these endangered animals, he said that like humans, some die, but the species does not become extinct (Onishi 2001). Few Africans have been taught about how close African Elephants came to extinction as a result of the ivory trade, nor about their key role in spreading the seeds of trees and creating waterholes for wildlife. It is also likely that only a small percentage of Africans are aware of the species' immense intelligence and altruism. If these facts were better known, it is likely that most Africans would want to protect these great animals. They are in imminent danger of disappearing from West Africa.

As they attempt to forage in land that is now being tilled or used as grazing land, Asian and African Elephants are killed and harassed by farmers and villagers outside national parks. Wildlife corridors are being proposed in many parts of the world to ease such problems. As human populations grow, invading the last retreats of wildlife, parks and

reserves are becoming islands amid development, agriculture and cities. Without corridors of natural habitat linking these islands, wildlife will decline in diversity and abundance. A new national park in Mozambique will link with South Africa's Kruger National Park and provide a corridor and additional habitat for Kruger's elephant populations. Other international parks in southern Africa have opened or are scheduled. Some conservationists have proposed that these parks form the southern end of a wide corridor north to Kenya. This would be an excellent solution to the declining habitat faced by many large mammals of eastern Africa. In the Western Hemisphere, the Atlantic Biological Corridor Project and the Mesoamerican Biological Corridor seek to protect wide swaths of land between Mexico and Colombia to prevent the extinction of wide-ranging animals, such as Jaguars and Cougars. Along Texas' border with Mexico, most of an extremely biologically rich area has been plowed under, and the Fish and Wildlife Service is trying to purchase the remnants of this once rich habitat to link it with adjacent habitat in Mexico for use by endangered wildlife.

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In the American West, Grizzly Bears may someday be able to roam from Yellowstone to Yukon in a project known as Y to Y, an immense corridor that would prevent the present isolation of this species into pockets of fragmented habitat surrounded by hostile cattle ranchers. The Wildlife Conservation Society has initiated a program it calls "Living Landscapes," which involves local people living in areas surrounding parks and reserves. It promotes the conservation of animals that have ranges extending beyond the parks in order to help conserve these species, allowing them to be part of functioning ecosystems. This sometimes involves curtailing their own hunting. White-lipped Peccaries, for example, a type of wild pig, are important seed dispersers of trees in Latin American rainforests and also create open spaces on the forest floor by rooting for food. Yet they are heavily hunted for their meat and pelts. Only through an education program in which the local people themselves understand the effects of their hunting and are permitted to manage the land, can the species and its habitat be protected. This organization is applying such approaches to regional conservation in 50 sites in Latin America, Asia, Africa and North America (WCS 2001).

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Another fundamental element to the future survival of wildlife in a world crowded with humans is tolerance and a belief that the Earth must be shared. Public opinion has been crucial in land use and protection of natural habitats and landscapes so that wildlife and plants were allowed to survive, even in parts of the world with overcrowding where land was at a premium. Fewer species are threatened in parts of the world where wildlife is respected and considered part of the landscape. In Africa, wildlife flourished when native peoples were the guardians of the land, prior to the 18th century when Europeans entered as colonial rulers. European rule resulted in overhunting and development of large-scale ranches and farms that were fenced, creating a drastic decline in wildlife.

Native Americans have a less proprietary view of nature than Europeans, and many tribes believe in spiritual connections with trees and animals. They treat nature's assets as gifts, for which they express gratitude. In the intervening centuries since colonization of North America by Europeans who failed to respect nature, views have come full circle for many Americans. Wilderness and nature preservation have become high priorities, based on both scientific discoveries about how ecosystems function and a growing desire by people to appreciate nature. Some scientists believe that connections with nature have been an intrinsic part of human nature for millions of years. Dr. Edward O. Wilson calls this "biophilia," or "love of living things," and cites it as a primary human trait. Such ties to nature have nurtured new conservation zeal to help preserve disappearing wildlife and landscapes.

For some people, however, even the most basic ecological and evolutionary principles are refuted in favor of views

that justify exploitation and species' extinctions. They describe conservationists as irrational "tree huggers," and animal lovers as "bunny huggers." Anti-environmentalists have formed organizations in the United States, operating collectively as the fiWise Usefl movement. Many elected government officials share these views, and have voted for legislation that fails to protect endangered species and results in destruction of important wildlife habitat. US Congresswoman Helen Chenoweth, a Republican from Idaho, believes that there should be a public referendum regarding which animals can live and which will be allowed to go extinct (Egan 1996). Chenoweth stated to *The New York Times*: "A species goes out of existence every 20 seconds. Surely a new species must come into existence every 20 seconds. There's no way human beings can regulate that dynamic" (Egan 1996). Humans can, indeed, affect the "dynamic," as they have for millennia, and when species are lost, their loss is our loss. Evolutionary biologists would be dumbfounded at her statement. Although species are passing into extinction at a fast rate, new ones are not evolving every 20 seconds, nor even every 20 years or every 200 years, unless one considers the mutations of viruses and bacteria to be new species. Once the Tiger or Right Whale--or any of Earth's myriad species--becomes extinct, it is gone forever. The film "Jurassic Park," which concerned the recreation of dinosaurs from their DNA, is total fiction. Science has not found a way to clone species from DNA obtained from dead animals because the DNA becomes scrambled after death. Nor are such scientific feats anticipated in the near future.

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The basic problem that many people find in protecting endangered species is the question of land ownership and the inconvenience that they fear may result when animal or plant habitat is protected. Congresswoman Chenoweth would find agreement among many people living along the Massachusetts coast, who are unwilling to share the beaches with a tiny endangered bird. This bird has caused storms of controversy between its protectors and recreational beach users. The Piping Plover (*Charadrius melodus*), a shorebird, nests on sandy beaches along Eastern coasts, the Mississippi River and the Great Lakes. It has been crowded out of the majority of its nesting sites by the hordes of people who come to swim, sunbathe and drive off-road vehicles. Beaches have been altered or developed for various commercial purposes as well, including levee construction for flood control. In 1985, the species numbered only a few thousand birds and was listed on the Endangered Species Act as Endangered in the Great Lakes, and as Threatened elsewhere in its range. The numbers of this species along the Atlantic coast, from southern Canada to South Carolina, reached 1,377 birds in 1998, and throughout its range, only about 5,913 birds survive (BI 2000). In Massachusetts, where most beaches are public, local authorities and even federal and state enforcement officers were reticent to enforce the law to protect the nesting plovers. Even when parent birds managed to raise chicks, the chicks were often run over by vehicles when they fell into the deep ruts on the beach made by tire tracks, unable to climb up the six inches of vertical sand or flee an oncoming vehicle in time. Plans in 1989 to fence a portion of the beach in Plymouth to protect the nesting birds met with such anger and public protests from beach-users that they were abandoned. In 1991, only a single chick survived in the state, with few beaches strictly protected. Unleashed dogs killed some of the chicks, but most were run over by cars and all-terrain vehicles.

On Nantucket island, a Massachusetts Audubon Society warden fenced in the nests of two Piping Plovers in 1994, causing such anger from off-road vehicle drivers that they called the police, who threatened to arrest the warden. Neither the state, which protects the species, nor the Fish and Wildlife Service came to the rescue of the Piping Plovers by supporting the actions of the warden. Vandals ripped down the protective fencing. Endangered Least Terns (*Sterna antillarum*) nesting on the same beach produced 24 chicks that year. In one day, 20 were run over. This finally convinced the local selectmen to close that portion of the beach to off-road vehicles, which allowed all eight Piping Plover chicks to survive. The citizens of Nantucket voted the following year to defeat a selectmen proposal to allow vehicle use on the beach, which would have exempted the area from state law protecting the plovers. In 1995, three pairs of Piping Plovers nested successfully on Nantucket, and state restrictions began going into effect to protect their nests.

In Massachusetts, nests increased from 139 in 1986, to 445 in 1995 (Allen 1996a). In a step backward, the state of Massachusetts eased restrictions on beach vehicles in 1996, giving what conservationists called "plover-squashing permits" (Allen 1996b). The Massachusetts Audubon Society estimated that at least 33 plovers would be legally killed each year under the new regulations. Another loss for Piping Plovers was the firing in September 1997 of the town of Plymouth's Beach Manager, who had spent more than a decade protecting these birds from off-road vehicles. This was done to appease recreational dune buggy users. The ban, which closed part of the beach until mid-August to allow the chicks to survive, was lifted. A civil complaint was filed in US District court in April 1998 to force the town of Plymouth to enforce the Endangered Species Act and protect nesting plovers. The following month, a judge ordered the town to prohibit off-road vehicles on the beach from May 19 through August 31, unless strict measures are enacted to protect the nesting birds.

At least one conflict concerning this endangered bird in 1997 had a happy ending. The Cape Cod town of Barnstable's Fourth of July fireworks were nearly canceled by the Fish and Wildlife Service for fear that they would disturb the nesting plovers. A local businessman offered the use of several barges from which to detonate the fireworks. The barges were towed far from shore, and the fireworks proceeded as scheduled. Conrad Troy, owner of Tucker-Roy Marine Towing and Salvaging, Inc., who had been contacted by the Massachusetts Audubon Society for his help, said; fiIf I was an endangered species, I would hope someone would come help me out. We can keep the piping plovers happy and the kids who want to see the fireworks happy" (Anand 1997).

These controversies are indications of a growing trend in which animals, especially endangered species, are no longer eliminated or killed in the United States without protest when they come into conflict with people. Listing a species on the Endangered Species Act is a major step. It is not an end in itself, however. Listing scarcely helped the plovers in the Plymouth beaches, however, because the law was not enforced when opposed by drivers of off-road vehicles and beach users. Only the combination of publicity, local support for the birds and demand for strict protection have resulted in protection of plover nests and habitat preservation. A large contingent of volunteers now works on behalf of these tiny birds. Such cases provide examples of what is needed to prevent extinctions.

Conflicts over protection of endangered species are sure to increase in the future. Only if the public support is stronger on behalf of wildlife than the influence of those who are indifferent or oppose endangered species protection, can endangered species survive. Public support for the less attractive and charismatic species, such as insects, fish, bats and nondescript plants, will come only through effective conservation education.

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Another highly endangered species that nests on beaches has been the subject of a successful reintroduction program sponsored by the Fish and Wildlife Service in cooperation with the Mexican government. The Kemp's Ridley (*Lepidochelys kempi*), smallest and rarest of all sea turtles, became endangered from killing for its meat and shell. Killed off by poachers in Texas, where it once nested, a long and difficult program was initiated to return these turtles to Padre Island. Thousands of eggs laid by the last 500 nesting females on the turtles™ only remaining nesting beach along the Caribbean coast of Mexico were taken to Texas for hatching. It is not known how sea turtles learn to return to their natal beaches after spending many years at sea, and all precautions were taken to convince the hatchling turtles that they had been hatched in Texas, not Mexico. The eggs were not even allowed to touch the sand on their Mexican beaches. Between 1978 and 1988, when the program was halted for lack of visible success, a total of 22,000 eggs had been taken to Padre Island, hatched, kept in captivity until they were about a year old and then released to the sea. In 1996, to the delight of conservationists, two female Ridley Turtles that had been released 12 and 14 years previously, returned to lay eggs on Padre Island. They were recognized by a special marking the US Fish and Wildlife Service had made on each shell identifying the year the turtles were hatched. By 1999, 16 nests of returning Ridley Turtles were found by volunteers and members of the recovery team who monitor the beach 24 hours a day

during the summer nesting season. This is the first known case of successful reintroduction of sea turtles. Numbers of these turtles have increased to about 9,000 in 2001, but they are still only a fraction of the 40,000 filmed nesting on a Mexican beach on a single day in the 1940s.

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Dramatic rescues of endangered species have become commonplace on the island of Mauritius through the efforts of teams headed by Dr. Carl Jones, a scientist working for the Wildlife Preservation Trust, founded by famed author and conservationist, Gerald Durrell. This island harbors some of the world's most endangered birds, and by the 1970s, conservationists had become resigned to the imminent extinction of several of these endemic birds and other endangered animals. In steep decline, they seemed to be following on the path of the Dodo. Crucial to the success of the efforts to reverse this trend was the agreement signed by the government of Mauritius with four conservation organizations in the 1980s, including the Wildlife Preservation Trust, to cooperate in preserving the island's natural heritage. A conservation program in the 1970s to protect the Mauritian Pink Pigeon (*Columba mayeri*) had failed, and the remaining 33 birds were dying off. Captive-bred birds failed to breed, and wild birds were dying from various causes. Jones arrived on the island in the 1980s and, after years of concerted effort in cooperation with a small staff, brought the wild population from a low of 10 birds to approximately 375 birds in 2000. Pink Pigeons now nest at four sites on Mauritius, and another on Ile aux Aigrettes, an islet off the coast (BI 2000). This spectacular increase was the result of a program in which exotic monkeys, rats, mongooses and feral cats were removed from the roosting and nesting grounds of these beautiful, pale pink birds. Captive-bred birds released to the wild were given food until they were independent, and nests were carefully monitored for predation, falling eggs and other mishaps (BI 2000). The program hopes to increase these pigeons to a population of 500 birds within five years.

The Mauritius Parakeet (*Psittacula eques*), once the most endangered parakeet in the world, became reduced to a total population of only six birds in 1978 (BI 2000). The captive-breeding program set up to preserve them in the 1970s was not successful, and the last wild birds were dying out. Jones and other experts in parrot breeding set up a new captive-breeding program and gave the few wild birds strict protection from the many threats that appeared almost certain to cause their extinction. These included an almost total loss of forest habitat, including old trees with nest holes; a lack of available food; monkeys and rats preying on nestlings; infestations by nest fly larvae; and competition for nest sites with various introduced birds and bees (BI 2000). In spite of these overwhelming odds, these lime green parakeets are making a slow recovery. A forest habitat of 8,000 acres has been made into a national park where exotic species have been excluded and captive breeding is now succeeding. At first, the wild parakeets refused to nest in boxes set out for them and would not try to find other nest sites if their nest tree were destroyed during hurricanes. Fortunately, a few pairs did nest, and habitat improvements were made, such as the planting of fruit trees as a food source. Through these and other efforts, the wild and captive populations rose to between 85 and 90 birds by 1997 (Hoyo *et al*. 1997). Numbers continued to rise, and by 2000, 106 to 126 birds survived (BI 2000). This is one of the world's most impressive conservation stories. The vast majority of birds whose populations have declined so drastically experience genetic impoverishment or become prone to other threats by failing to respond to conservation programs. The recent extinctions of Hawaii's honeycreepers and other native birds are testament to the failure of many 11th-hour programs to conserve critically endangered birds. Although still listed as Critical by BirdLife International (2000) and the IUCN, the Mauritius Parakeet may be reclassified as Endangered, should present trends continue (BI 2000).

A third endangered bird of this island, the Mauritius Kestrel (*Falco punctatus*), a small falcon, numbered only four birds in 1974, coming the closest to extinction of any Mauritian bird. Yet today the species is numerous, having almost completely recovered. Through captive breeding and restocking birds to the wild using methods employed in the United States for Peregrine Falcons, and with the help of the Peregrine Fund, hundreds of captive-bred birds have been released to the wild and fed at release sites until they gradually sought wild prey. By 1995, these kestrels totaled

286 birds (Jones and Hartley 1995). Control measures have been successful in reducing exotic species that preyed on them. The population of Mauritius Kestrels reached 145 to 200 breeding pairs in 2000; the species totals from 500 to 800 individual birds who live in three subpopulations in various parts of the island (BI 2000). Jones has also worked to restore habitats for various endangered lizards that are captive bred at the headquarters of the Jersey Wildlife Preservation Trust. These small, iridescent geckoes had become restricted to out-islets, where they survived because introduced predators were absent. Unfortunately, rabbits were released on Round Island, habitat for several of these endangered reptiles, and they multiplied to pest proportions, leaving almost no natural vegetation. Many of these lizards were captured just in the nick of time, and bred in captivity, as the last of their habitat was being consumed. After removal of the rabbits and replanting of native species, these lizards are now being reintroduced.

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Specimens of a highly endangered fruit bat of the small Mascarene island of Rodrigues, the Rodrigues Flying-fox (*Pteropus rodricensis*), were captured for captive breeding when wild populations became threatened by killing for food by local people. It amazed researchers studying them when a female exhibited mid-wife protective behavior seen only in a few other animals, such as dolphins and elephants. One of the females in the process of a difficult breach birth was aided by the other, who fanned her, cradled her in her wings, and showed her the proper position to cling to the cage bar during the three-hour delivery (McFarling 1994). Wild populations of this species are listed as Critical by the *2000 IUCN Red List*. Other flying foxes that once inhabited these islands are now extinct, and the Rodrigues Flying-fox is the last to survive. Without the emergency rescue of some of these foxes, the altruism and devotion of these animals would probably not have been recognized.

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The elimination of introduced animals, from goats, cattle and pigs to cats and exotic plants, has been carried out on many islands and island-like environments around the world to preserve native species on the brink of extinction. The governments of Australia and New Zealand, in particular, have rescued a number of critically endangered species. Lord Howe Island, located off the northeastern coast of Australia, once harbored diverse wildlife. After settlement, and introduction of rats and other exotic species, forest clearance and other threats, numerous extinctions of native animals occurred, and most of its surviving species are endangered. Efforts on the part of the government to return the island to its near-original state, with total protection of the remaining tropical forests, coral reefs and other habitats, is underway. Ecotourism has been developed on the island, but the number of visitors is kept at a level that will not harm the island's endemic fauna and flora. Cats may not be kept by the limited number of residents as pets because of their threat to native birds, and exotic animals are being eliminated from the wild. The endangered, flightless Lord Howe Rails (*Gallirallus sylvestris*), highly vulnerable to predation by cats and other predators, are now gradually increasing with strict protection. Once found throughout the island, these rails became restricted to mountain areas after they were eliminated by feral pigs, goats, cats, dogs and the introduced Masked Owl (*Tyto novaehollandiae*) elsewhere on the island. Captive breeding has been successful, and after work to eliminate exotic animals, these rails were reintroduced to several of their original habitats at lower elevations (BI 2000). The population numbers about 130 birds, with a potential living space for up to 220 birds (BI 2000).

In some cases, control programs for exotic species on islands are not done humanely. Wire snares and poison have been employed rather than live-catch traps, for example. Humane organizations should be consulted by governments to employ humane methods in ridding islands of non-native animals.

The Black Robin (*Petroica traversi*), a beautiful songbird resident on the Chatham Islands off New Zealand,

numbered just five birds in 1980, with only one breeding pair (BI 2000). Rats and cats colonized the island after settlement, and deforestation had destroyed the species' habitat. A tree-planting project in which 120,000 trees were planted on Mangere Island, one of its prime habitats, was undertaken (BI 2000). Supplemental feeding and nest protection from introduced Starlings (*Sturnus vulgarus*) and seabirds, which were preying on them, helped somewhat. Real progress began with the use of an unusual program in which eggs of the Black Robin were placed in the nests of other species to raise them and allow the original female, who became known as "Old Blue" and lived 12 years, to lay more eggs. Birds of a related species, the Tomtit (*Petroica macrocephala*), raised these robins, and chicks were successfully reintroduced to Mangere Island (BI 2000). Such cross-fostering has failed with species such as the Whooping Crane, whose eggs were cross-fostered to Sandhill Cranes, because the chicks when mature, tried to mate with Sandhill Cranes instead of members of their own species, having become imprinted. In this case, the chicks bred with members of their own species, and numbers rose to 259 in 2000 (BI 2000). They were all descended from the original pair of birds. The New Zealand Department of Conservation, which had overseen the breeding program, found through DNA studies that the birds are nearly identical genetically (Hutching 1997). Further studies will attempt to discover immune responses and other signs of inbreeding, but outwardly, these robins are thriving, with a 70 percent survival rate and normal fertility (Hutching 1997). Species with such low genetic variability tend to be extremely vulnerable to extinction, having little ability to adjust to changes in their environment or food supply.

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More and more countries are taking a keen interest in the preservation of wildlife, and some have ancient protective traditions. The Asian country of Bhutan has a Buddhist ethic of not harming living things. It is the only Himalayan country to have protected the majority of its forests. Rhododendron species 40 feet tall grow there, and the rivers still flow clear, without erosion and siltation. Species that are rare elsewhere in the region still survive in Bhutan. One of its protected areas, Jigme Dorji National Park, is the size of Switzerland and preserves spectacular mountains and cascading waterfalls. It is part of a Bhutanese government plan to create a nationwide system of reserves to protect the country's natural heritage (Adams 1994). Although erosion and destruction of some of the native fir and rhododendron forests have occurred, Bhutanese people support the government's "go slow" approach to development and its plan to preserve wilderness (Adams 1994). A wintering population of endangered Black-necked Cranes (*Grus nigricollis*) is zealously protected by the Bhutanese who live in the valley where the cranes come each year; they regard the birds as integral to their lives and believe that, without them, their harvests will fail. These people miss the cranes™ calling when the birds migrate in the spring, and say that the valley seems empty and silent without them (Greenway 1997). The Environment Ministry watches over the cranes as well and is extremely strict about issuing permits for activities that might harm them.

New approaches may save some of these threatened tropical areas. Australia's Rainforest Information Center has created an Internet website which plays rock and roll music; its sponsors pay to preserve the rainforest (EII 2001). The organization is focusing on saving several endangered forests in Ecuador, including Los Cedros Biological Reserve and portions of the Madre Selva (EII 2001). The Natural Resources Defense Council has created a list of BioGems (www.savebiogems.org), the 12 most endangered wildlands in North and Latin America. It publicizes threats, such as proposed dams and logging, to generate thousands of letters and e-mails to governments, loggers, utilities and others. The Macal River Valley in Belize, threatened by a dam project, has been saved through this program. The US Duke Energy International company decided to withdraw from Belize after the torrent of protests (NRDC 2001). Boise Cascade planned a major wood chip mill in Chile, which would have consumed 1,200 acres of endangered temperate rainforest a year, with endangered Alerce trees, the massive South American counterpart to the Sequoia. The forests also sheltered tiny Pudu deer and rare birds. The company announced that it would cancel its plans "as a result of unfavorable market conditions" (NRDC 2001). Conservation International (CI) played an important role in the designation by the South American country of Suriname of much of its vast interior, a pristine rainforest, as a reserve. CI, through its scientific studies, was able to show the country's leaders that, kept intact rather

than being logged, this rainforest would prove far more valuable for future generations. This organization has accomplished similar feats in Bolivia and other parts of the world, where it also carries out important biological inventories.

An example of cooperating with local people for conservation of wildlife is the administration of the Mara Reserve of Kenya. This reserve is run by the Maasai people through a council which mandates that tourist funds go directly for social services of the tribe; in turn, the Maasai, who live outside the reserve, allow wildlife to move freely without fencing or harassment that is common elsewhere in Africa where livestock is raised (Gakahu 1994). In this reserve are endangered Cheetahs and Black Rhinos, along with 30 species of ungulates, including large numbers of elephants (Gakahu 1994). Local villages in many parts of Kenya are establishing landowner associations that receive funds from tourism to protect wildlife and benefit local economies (Gakahu 1994).

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Teaching people that their local wildlife is important to protect as a source of pride has had excellent results in a program in the Caribbean funded by RARE Center for Tropical Bird Conservation, an organization headquartered at Philadelphia's Academy of Sciences. It has employed innovative education and conservation programs to preserve St. Lucia Parrots or Amazons (*Amazona versicolor*), the forests and other wildlife of the island. Biologist Paul Butler, who began this program, has instilled conservation enthusiasm and pride in the people of the island of St. Lucia for these beautiful and rare parrots. His dynamic program has resulted in the naming of this species as the national bird, as well as education programs so successful that children know its scientific name, habitat and need for protection. They enjoy singing songs about the parrots and dressing up in parrot costumes. The people of St. Lucia now understand that the forest and other wildlife must not be destroyed. Art and essay contests are conducted in schools and towns to publicize this parrot, and St. Lucia Parrots are used as logos for many businesses. Forest cutting has been banned, and a substantial portion of the island has been set aside in reserves. This has resulted in an increase from fewer than 300 to between 350 and 500 birds (BI 2000). The Saint Lucia government is dedicated to protecting the parrots and their habitat, and a new ecotourism industry has sprung up. These programs have meant an end to the rampant smuggling of these beautiful, rare parrots, an activity that had been thought uncontrollable because they could be sold for $20,000 per bird to collectors. Protecting the forest for the parrots also resulted in conserving other threatened wildlife of the island and precious watershed. Another native species, the spectacular Giant Swallowtail butterfly, is illustrated on billboards prominently located near towns with the message, "It's ours . . . take care!!!" (Lipske 1994). This approach to conserving endemic wildlife has been adopted on other Caribbean islands, and Butler trains local conservation officers and teachers to continue the programs elsewhere (Butler 1992, Lipske 1994). A film about these programs, "Caribbean Cool," is described in the Video section, and RARE has published a manual, *Promoting Protection Through Pride*, with advice on how to carry out such programs.

Educating children to respect the environment and conserve endangered species leaves a lasting impression if begun in grade school and continued throughout schooling. Children have an innate sympathy and love for animals, and become enthusiastic conservationists. Education about national laws and native wildlife and plants of the region encourages students to have a lifelong desire to protect them and a sense of guardianship that results in opposition to actions that would harm them. Environmental education is required in about two-thirds of US states, from grade school onward. Some schools require special training in environmental science for all teachers. A few high schools are teaching courses in ecology for college credit. The North American Association for Environmental Education has issued detailed guidelines for educators to assess textbooks and other materials for fairness and accuracy, and review by experts (Cushman 1997).

Some conservation organizations have been formed by scientists, such as the highly effective International Crane Foundation and Bat Conservation International. Entertainers have also become involved in conservation. The rock

music star Sting, for example, became concerned about the destruction of rainforests and founded the Rainforest Foundation, an organization to raise money to purchase or protect thousands of acres of this endangered habitat, while at the same time informing young people about the importance of these forests to the world. Students and concerned individuals have also founded organizations to protect individual species or particular environments, such as prairies or wetlands. These organizations have raised millions of dollars for rainforest protection and helped many endangered animals.

A number of effective conservation programs began as grassroots organizations established by an individual or a small group of people who wanted to protect a species. Individuals have educated, lobbied and helped raise funds for the purchase of habitat, making extremely important contributions to the preservation of threatened species. The beautiful bluebirds of North America were in steep decline until Lawrence Zeleny began his nesting box program. He popularized and distributed nesting boxes for bluebirds with an entry hole just a fraction of an inch too small for the aggressive European Starlings to enter. The latter birds are taking over the tree nest holes of all three species of North American bluebirds. Starlings are also a threat to several native species of woodpeckers. Through the nest box program promoted by Girl and Boy Scout troops and other organizations, these colorful birds have increased and may again be abundant, familiar residents of orchards, woodland edges and grasslands. Such citizen projects keep species in decline from reaching endangered status. Once endangered, a species' genetic diversity is threatened, and multi-million-dollar state and federal rescue programs, which are not always successful, must be set up to help them.

Only a small percentage of endangered species have such programs in place to aid their populations and protect their habitat, and individuals can make important contributions by volunteering for organizations working to preserve species and their habitats or by founding an ad hoc group. The majority of species listed on the *2000 IUCN Red List* or on Natural Heritage would be far more likely to avoid extinction if conservation programs were created for them, with help from both individuals and organizations. The species most in need are invertebrates and plants, which form the majority of all endangered species and receive the least funding. Within each region or county, little-known endangered species may be fading out without the aid of any organization or individual. Organizations such as The Nature Conservancy, Conservation International, scientists with the IUCN or state Natural Heritage programs provide highly specific information on threatened species in various parts of the world.

Restoration of original ecosystems will become more and more important as natural landscapes decline. The Nature Conservancy, which has purchased millions of acres of land to preserve resident endangered plants and animals, reintroduced the American Bison to its 30,000-acre tallgrass prairie in Oklahoma, and is reintroducing native flowers, plants and animals to restore at least a portion of this magnificent ecosystem. After decades of failed bills proposed in Congress, legislation was finally enacted in 1996 establishing the nation's first tallgrass prairie park of more than 10,000 acres in Kansas. Individuals can also contribute to restoration of ecosystems. Books, such as *Noah's Garden. Restoring the Ecology of Our Own Back Yards*, by Sara Stein (1993), and many magazine articles have called attention to the effects of suburbanization, and the poisoning of native wildlife with pesticides and herbicides used on lawns. They suggest means of bringing back natural ecosystems.

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However effective private organizations are, they cannot begin to have the effect of preserving habitat that governments have. As the owner of millions of acres of parks and reserves, the US government plays a major role in habitat and species preservation. The Land and Water Conservation Fund was established in 1964 to purchase and preserve federal lands, with money coming from oil and gas leases on the coasts. Each year, some $900 million is deposited in this fund, and more than 5 million acres have been preserved in many threatened environments. In 1998, $699 million was approved for spending on land purchases, including $250 million for acquiring the ancient Headwaters Redwood Forest in California to save it from planned logging, as well as $65 million for the New World

Mine site near Yellowstone National Park to save it from a huge Canadian gold mine.

National Wildlife Refuges are vital habitat for thousands of threatened and declining species and were first set aside during the Theodore Roosevelt Administration to protect endangered sea birds being killed for their plumes. Now refuges and preserves are key to the survival of Red Wolves, Bald Eagles, Whooping Cranes, Florida Panthers and numerous rare plants, butterflies and other wildlife. In many of these refuges, oil drilling and other exploitation occurs, causing damage to ecosystems and threatened wildlife. The protection these refuges receive is far less stringent than that of national parks and monuments. In some refuges, high-speed roads cut through the middle of marshes where an array of rails, turtles and wetland species end up run over by vehicles. In the largest refuge, the Arctic National Wildlife Refuge, most of the land is open to oil drilling, where water and air pollution have been severe problems. The calving ground of a herd of some 100,000 Caribou within the refuge has been proposed for oil drilling, in spite of the opposition of the majority of the US public. With greater support from the public, laws governing these refuges and their funding might be strengthened to better preserve wildlife.

Some imaginative solutions to the funding problem have been developed. A number of organizations have adoption programs for wild animals. Northern Right and Humpback Whales, for example, identified individually by their markings by scientists studying them, can be sponsored by members of the public, who are then informed of news about their adopted animal. The funds are applied to research and conservation of the species. Grizzly Bears, Tigers, Gray Wolves and other animals may be adopted through a growing number of organizations. Earthwatch, in Watertown, Massachusetts, sponsors thousands of research expeditions by scientists, many of them studying endangered species, through funds from volunteers who pay for the privilege of accompanying the scientists and helping in the research. Endangered species of Brazil's Atlantic Forest, Florida Manatees, rare butterflies and coral reefs are among the many projects Earthwatch helps fund. This organization also awards hundreds of scholarships to students, and teachers who participate can turn the experience into a study program for their students.

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A great blossoming in natural history information has erupted in recent years. Internet websites, accessible to all, have been dedicated to endangered species research programs, biological studies, organizations devoted to helping animals and data compilations. The Internet sets up communications between people around the world, in which education, advice, and even funding help for threatened species and ecosystems can be arranged. Critical situations threatening species can be publicized immediately around the world. On the Internet, students and the public can follow the movements of individual sea turtles, great whales and many other animals equipped with radio transmitters sending signals to satellites. Libraries can be accessed, and websites set up by state, federal and private entities provide highly specific information on endangered species and the environment. Experts may be consulted through these sites. In a recent case, a man in Lebanon came upon an injured eagle with a gunshot wound; he took the bird home and logged on to the National Geographic Society's website (see Teachers™ Aids in the Appendix for lists of websites) to find Joe Blanton's "Glad You Asked" column. Blanton put him in touch with the Wildlife Center of Virginia, whose staff at its state-of-the-art animal hospital gave him advice on care for the eagle. The man reported that the bird recovered and was released (reported in *National Geographic* June 1997). The possibilities of educating and dispensing information around the world are enormous, and with imagination, many of the problems discussed above might be solved through the free interchange of ideas of people on the Internet.

The Internet is only one new tool for conservationists. Laser discs can combine films and books and be interactive in teaching about subjects such as endangered Chimpanzees. CD-ROMs, although not yet available for many endangered species, contain--on one disc--still photos, films and printed information about a species; heretofore one might have to visit many libraries, rent or buy films by mail and spend many hours to obtain such information sources.

Books, television programs and films about the natural world have opened new doors to the public in the past decade. Natural history films, in particular, are another major influence on education and even public policy. They present views of true wilderness, natural wildlife behavior and conservation lessons. They may have had a significant influence on convincing the public of the need to pass such laws as the Endangered Species Act. Films of the slaughter of spotted cats, American Alligator, and the plight of declining species around the world aroused many people to write their Representatives and Senators in support of legislation to prevent species from becoming extinct.

Films of truly wild places may have played a role in the growth in bird watching and ecotourism, and probably in the changes that have taken place in zoos, with barred cages giving way to more natural exhibits. Having seen films of these animals in the wild, the public was no longer content to see them in such unnatural conditions, behaving so abnormally. Situations once commonplace, such as a pacing Tiger in a barred cage, a single elephant in a dusty, small enclosure, rocking back and forth, now result in protests that have changed zoo exhibits and animal treatment for the better.

The crucial steps that must be taken in the future involve the dissemination of knowledge and concern about endangered species to the general public, who are poorly informed about the enormity and possible effects on their lives of issues such as overpopulation and disappearing species. Although public awareness has increased about environmental decay and the effect that humans have in causing species' extinctions and endangering them, most people still tend to act as if nature will bounce back and will continue to function normally, no matter how extreme the damage. This is a naive point of view. Scientists have not defined the threshold beyond which total ecological collapse will occur in any given area. Also unknown is the number of species that can be extinguished before biological systems become dysfunctional (Leakey and Lewin 1995).

Newspapers, television and other media should be encouraged to publicize these issues further, rather than catering to what they might consider the public's interest. As an example, US network television and newspapers have pointedly ignored human overpopulation and loss of biodiversity, while doing numerous stories on artificial means of having children, such as test tube babies and multiple births. On the positive side, new cable television channels in the United States, such as Animal Planet and BBC, add to the growing number of wildlife and environmental programs on PBS and the Discovery Channel. Unfortunately, these channels presently reach only a fraction of the audience of network television, preventing a better understanding by the public of the problems facing the world. The numbers of films being made and books written on endangered species and the environment have increased exponentially in the past decade, an indication of a growing enthusiasm for the natural world. Other indications of this trend are the rise in memberships in conservation and humane organizations, ecotourism, bird-watching, hiking and visits to national parks and preserves. If these concerns were better translated to activism and altering lifestyles to prevent harming the environment and wildlife, impending mass extinctions might be avoided.

Biodiversity Preservation

Preventing loss of diversity through the growing number and rate of extinctions is extremely important for the ecological stability of the planet. Unfortunately, it is not recognized as a key issue by the majority of people, nor by world leaders. The extraordinary wealth of plants and animals that are in the process of disappearing may represent between 5 and 30 million species, of which only about 1.3 million have been named (Wilson 1993). Insects alone may number more than 5 million species, with the majority of species living in tropical rainforests (Wilson 1993). These animals are key to the Earth's ecosystems, pollinating, fertilizing and aerating soil, and providing food for thousands of animals. Some 751,000 animal species have been identified, far more than the 248,428 plant species, yet these represent only about 15 percent of all living species, in the view of Dr. Edward O. Wilson in his classic 1993 book, *Biodiversity*. Each year, thousands of new species of insects and other invertebrates, hundreds of frogs and,

surprisingly, primates, antelope and birds are discovered by science, often in disappearing habitats.

Worldwide, biological inventories, essential to the process of protecting biologically rich areas, receive inadequate funding. Wilson has estimated that more money is spent in New York City's bars in two weeks than studying biodiversity around the world each year (Farnsworth 1994). Some $57 billion is spent on drugs by Americans annually, according to the White House Office of National Drug Control Policy, while less than $1 billion are spent on inventories and biological studies, by some estimates. The lack of funding for biological surveys means that entire ecosystems are vanishing before they are even studied.

Just as many species are disappearing from neglect or uncaring development, scientists are finding and naming hundreds of new life forms, primarily through research programs of private universities and organizations. Ecosystems thought sterile, such as deep ocean environments, are now known to contain significant species diversity. Each descent of a submersible vehicle into these environments brings new discoveries, from beautiful, bioluminescent jellyfish many feet long to bizarre creatures that seem to have emerged from science fiction tales. Many of these newly described species represent previously unknown families, classes, and even phyla of animals.

Some deep sea creatures inhabit the boiling hot water emitted from cracks in the ocean floor, managing to survive what would be toxic to 99 percent of the world's animals. This environment may be similar to the one in which life itself was formed billions of years ago. These areas should be given high priority for government research funding. Studies about Earth™s diversity should not be sacrificed in US federal spending projects such as NASA probes into the possible presence of microbial life on Mars. The discovery of the Mars fifossilfl was given enormous publicity, and in early 1998, chemical studies proved that these supposed evidences of life were actually terrestrial contamination (Wilford 1998). This has not stopped the NASA program from searching for evidence of life on Mars. Tropical forests also represent frontiers to biologists in urgent need of research funding, with millions of species of birds, mammals, insects and other life forms yet undiscovered. They are proof of the importance and urgency of preventing extinctions and degradation of natural ecosystems.

Diversity is threatened by economic concerns that affect every country. Economists tend to consider revenue important--but not such intangibles as biological diversity. Yet history shows that cultures that protect their environment endure far longer than those that do not. Clive Ponting (1991), in *A Green History of the Earth*, makes this point clearly, citing the great civilizations of the past which died out after abusing the land by disrupting water supplies through deforestation, and causing imbalances in ecosystems that resulted in their decline.

Common sense about environment protection and a concern for future generations have inspired many countries and cultures to preserve biodiversity. Those cultures which have a strong bond with nature, especially a spiritual one, are the most likely to protect their environments and wildlife, even when they are impoverished and would profit from exploiting it. With such people, economic arguments to protect nature are unnecessary, but for the vast majority of people today, short-term profits from nature are justifiable if an urgent economic need exists. In general, harm to the environment and biodiversity may be increasingly unacceptable, however. Polls taken in 2001 in the United States found strong support for environmental protection, with 58 percent of respondents believing that protecting plants and animals should take priority over preserving personal property rights, and nine in 10 saying that it is important for wilderness and open spaces to be preserved (Barabak 2001). Even when government leaders fail to act decisively to protect nature, these actions do not necessarily reflect the will of the majority.

A new activism on the part of the public and native peoples is resulting in many protections for wildlife and the environment. It is also resulting in new alignments of organizations and groups of people. Environmentalists and labor groups have united in opposing the anti-environmental aspects of the World Trade Organization, which caused member countries to reexamine their automatic endorsement of all trade to the exclusion of the environment, wildlife and job protection. Native tribes in British Columbia and conservation organizations united to publicize the impending destruction of thousand-year-old forests along the coast, home to the white "spirit bear." This coalition succeeded in 2001 in stopping logging and achieving permanent protection for some 1.5 million acres (NRDC 2001).

One proposed means of preserving wild animals and plants and their environments is the Convention on Biological Diversity, signed by more than 150 countries after it was presented at the 1992 Earth Summit held in Rio de Janeiro, Brazil. It went into effect in December 1993, after the 30th country, Mongolia, ratified it. It had been signed by 161 nations. Its purpose is to prevent extinctions and biological impoverishment, and it commits nations that ratify it to take actions to preserve species and ecosystems in the process of development.

The Convention requires nations to integrate conservation into economic and social policy to: promote the protection of entire ecosystems, set up protected areas, undertake biological inventories, preserve species throughout the country and restore degraded ecosystems. Many of the wealthy industrialized nations that do not support the Convention succeeded in having weakening clauses written into it, such as "as far as possible" and "as appropriate" (Stevens 1992). It states that nations have the "sovereign right to exploit their own resources pursuant to their own environmental policies.fl Even with its weaknesses, it remains the only international convention to have ever addressed the importance of preserving biological diversity, and as such, it sets a major precedent.

The success of the Convention on Biological Diversity will depend on how strictly it is interpreted. One clause places economic and social development, and the eradication of poverty, as the first priorities of developing countries. This could become an excuse to allow extinctions for the sake of "progress." For example, dam construction or forest clearance could be projects to alleviate poverty, but they would probably cause extinctions. The treaty also states that conservation efforts on the part of developing nations will depend on the flow of money from rich nations, although it recommends that the rich countries benefiting economically from exploitation of resources, such as pharmaceuticals, in poorer countries, should share these profits with the latter (Stevens 1992). It is this latter clause that many members of the US Congress opposed because US pharmaceutical companies did not wish to pay nations harboring medicinal plants. This is a major reason why the United States has not ratified the Convention.

To fund the programs of the Convention on Biological Diversity in developing countries, the Global Environmental Facility (GEF) has been set up, administered jointly by the United Nations Development Program (UNDP), the United Nations Environment Program (UNEP) and the World Bank. GEF raised some $2 billion from wealthy countries, and its administration has been criticized by both donor nations, which want it run in a similar manner to the World Bank, and many developing countries and environmentalists, who accuse it of "green washing" destructive environmental programs endorsed by the World Bank (Lewis 1994). The World Bank has been a major proponent of commercial logging in the last tropical rainforests of Central and West Africa, with disastrous consequences for both wildlife and native peoples.

This Convention is heavily influenced by rich donor countries, such as Japan, Canada, Norway and other European nations. Without strong opposition to the traditional approach of the World Bank in funding large dams, logging and other such projects, the Convention will not fulfill its more positive potentials to conserve the Earth's biological heritage. Its success will depend on the strong participation of those truly interested in the preservation of nature and willing to encourage countries in this task.

At the end of the 20th century, a poll of biologists was taken, asking them what they considered the greatest threat facing the Earth today. By a wide margin, they chose the loss of biodiversity. The greatest challenge in the 21st century will be to inspire people to want to protect biological diversity, as some nations are doing. Costa Rica, for example, is engaged in a biodiversity program that will catalog virtually every resident animal and plant over the next decades and protect critical habitat areas. The United States, through the Natural Heritage Programs and hundreds of biologists whose work is compiled by the Association for Biodiversity Information, is making progress in its appraisal of the nation's biodiversity and conservation needs (Stein *et al*. 2000). Thousands of individuals are also playing a role by preserving or reintroducing native species into their local areas. In spite of great pressure to exploit the last rainforests and other fragile environments throughout the world, successes in preserving the immense treasure-trove of species that exists on Earth may be turning the tide.

Our lives depend on the proper functioning of the Earth's systems for processes such as photosynthesis, balance of oxygen and carbon, pollination of flowering plants and enrichment of the soil by organic materials. These systems require a large variety of species to function normally, and we are only beginning to understand the role of various organisms and which species are key to each ecosystem. It is not possible to say, therefore, that any species can become extinct without affecting vital life processes. By choosing which species shall survive and which are dispensable, based on economic considerations, as proposed by many politicians, is sheer folly. Irreparable damage may result from such attitudes, yet they are accepted by many governments of the world.

We are presently witnessing the breakdown of many ecosystems. Marine food chains are being destroyed by overfishing and pollution, interfering with the food supply for millions of people. Yet it seems that few of these ecological catastrophes were predicted when fishery or pollution limits were set. Likewise, wetlands are losing wading birds, frogs and fish--all natural insect controls--resulting in increases in insect-borne diseases such as malaria. Predator-prey relations are key to the health of forests and grasslands, preventing overgrazing by prey species that have lost their predators. Yet most wild cats and wolves are in decline, some close to extinction, allowing imbalances to occur. In a growing number of regions, large predators are either absent or so rare that they no longer perform their ecological role. In Yellowstone National Park, for example, the eradication of the Gray Wolf resulted in overpopulation of Elk, which over-browsed aspen and other plants that were habitat to a number of birds and other animals, resulting in their disappearance. Only with the reintroduction of wolves is the ecosystem returning to normal. The overpopulation of deer in the United States and their effect on preventing natural forest regeneration and destroying wildlife habitat is directly related to the extermination of their natural predators, wolves and Mountain Lions. In other cases, prey species, such as deer, antelope and other ungulates, are in steep decline, having been killed off by meat hunters or crowded out by livestock. These species often play important roles in dispersing seeds, as do bats, birds and rodents. One-fourth of all mammals, and one in 10 birds are imperiled. Among these are pollinators, seed dispersers, insect-eaters and prey for other species. The loss of this biodiversity is reaching such levels that it is not surprising so many ecosystems are imbalanced. It is even more alarming to contemplate that the majority of the world's reptiles, amphibians, marine fish and most invertebrates have not even been assessed by biologists.

Species' declines begin with local extinctions as they disappear from portions of their ranges. At this stage, their absence may be affecting ecological communities, but they will not be listed by the IUCN or any other listing authority until the species as a whole becomes threatened. The Gray Wolf disappeared from 90 percent of its US range before it was listed on the Endangered Species Act, by which time major ecological damage had already been done. Species receive protection, endangered listing and conservation attention at the latter stages of declines. The smaller the original range, the faster that species slides to extinction. Ecological effects can occur gradually and imperceptibly in some cases and, in others, quickly and dramatically. Most of the 34,000 plants listed by the IUCN as Threatened occupy restricted ranges and may have undergone slow declines as their pollinators and seed dispersers disappeared, or rapid declines if they were logged or their habitats destroyed. As the concept of saving ecosystems and their myriad plants and animals gains acceptance, the importance of preserving all the strands of this complex tapestry becomes clear. The tens of thousands of animals and plants listed by the *2000 IUCN Red List* are an indication of a crisis situation, of nature going awry.

Astronauts orbiting the Earth have been overwhelmed by the beauty and fragility of the planet and its uniqueness in the universe. They have described environmental destruction visible from space. Shuttle astronaut Jay Apt (1996) spoke of seeing hundreds of pinpoints of bright lights at night that turned out to be fires emanating from forests in Africa, Madagascar and Borneo. A distant perspective enhances appreciation and desire to conserve our remarkable home. Instead of considering ourselves as separate from the environment, biologist Dr. Thomas E. Lovejoy has suggested, "We must behave as if we live *within* ecosystems, rather than perceiving nature as something confined to a few protected areas isolated within a degraded, human-dominated landscape" (Laurance and Bierregaard 1997).

Scientific study of Earth's diversity and ecology is in its early stages, and an exciting frontier awaits scientists in the ocean, tropical forests and other environments. Yet we are treating this precious living tapestry without the respect it deserves, and the unraveling of these intricate and delicate ecosystems will threaten our very existence.

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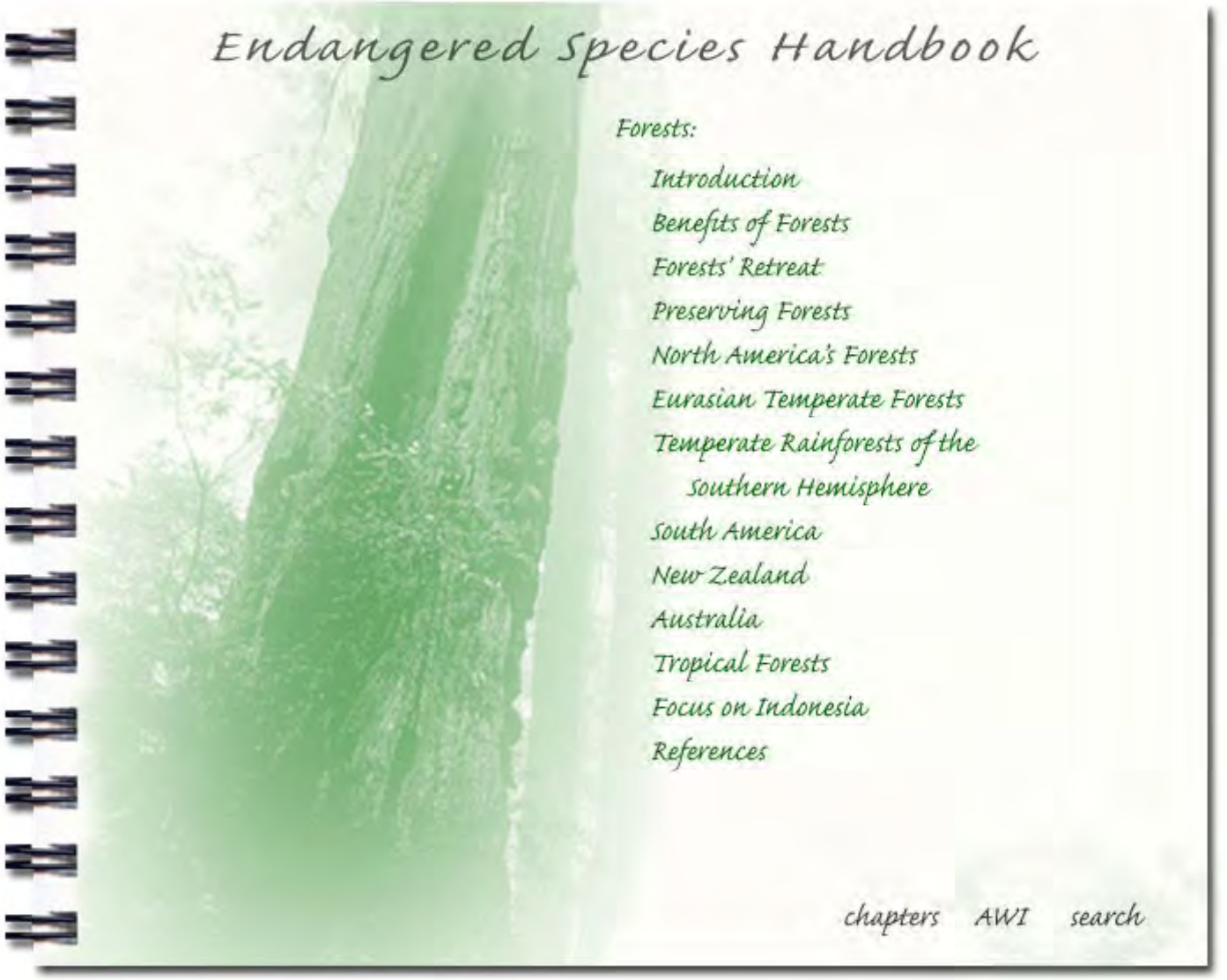

Forests:

Forest

Introduction

In an Ecuadorian rainforest, great towering trees festooned with orchids whir with hummingbirds. Primitive mammals skitter up massive Australian trees of species older than the dinosaurs. The world's tallest trees grow in northern California; at the forest floor beneath them grows an intricate diversity of emerald green mosses and ferns inhabited by tiny creatures. At the southern end of the South American continent, a forest of small gnarled trees buffeted by sea winds shelters herds of short-legged Huemul deer. Kiwis, in their downy cloaks of brown feathers, probe the forest litter among giant tree ferns in New Zealand's dark rainforests, pushing their long, pointed bills into the soil to extract earthworms. Monkeys with elaborate facial patterns, in blues, reds and blacks, chatter in treetops above a plodding West African elephant herd. New Guinea's dazzling birdwing butterflies, measuring 1 foot across, flutter near moss-hung trees where iridescent birds-of-paradise display and utter resounding, eerie calls. Thousands of insects and hundreds of other life forms may inhabit a single tree, whose fruits and flowers feed countless other animals, each the product of eons of evolution and geological history. These irreplaceable forests are in imminent danger of disappearing. The most biologically diverse of these are the untouched, old-growth forests of the world, of which only 20 percent remain, largely unprotected from destruction.

Benefits of Forests

The great beauty and inspirational qualities of forests belie their important biological tasks. By producing vast amounts of oxygen and water vapor, and absorbing carbon dioxide, they help support all life on Earth. A single mature oak tree produces enough oxygen to keep eight people alive for a year. In 1995, an international team of ecologists working in Brazil documented that each hectare (2.47 acres) of undisturbed tropical rainforests absorbs 1 ton of carbon dioxide per year. The world's rainforests are thus absorbing a billion tons of carbon dioxide a year, one-sixth the amount produced by burning fossil fuels such as oil and coal, according to the National Oceanic and Atmospheric Administration (NOAA). Cutting and burning of forests around the world releases carbon dioxide into the air. The high levels of carbon dioxide in the world's atmosphere have caused increases in average global temperatures. The value of tropical forests in trapping carbon dioxide is so significant that four US utility companies have sponsored a pilot program in Belize to protect large areas of forest and plant trees; energy companies will contribute $2.6 million to a 120,000-acre reserve that will absorb 5.2 million tons of carbon dioxide gas over 40 years (Geatz 1996). The Clean Air Act allows such "pollution credits" to compensate for pollution released elsewhere. In 2000, the US government proposed a massive program of tree planting and protection of forests to compensate for the effects of global warming caused by the release of carbon dioxide and other pollutants.

The cooling effect of forests results from leaf transpiration generating moisture that rises to the atmosphere, forming clouds which release water as rain or other precipitation. When forests are cut, the climate dries as rainfall decreases and soils lose moisture. Tree roots absorb about one•half of the rain that falls, releasing the water gradually during the year (Schreiber *et al*. 1989). In countries with wet and dry seasons, water retention by trees makes the difference between deadly floods that kill thousands of people and sweep away their homes and precious topsoil, and river levels that remain stable, preserving soil and the environment. Forests stabilize the soil, preventing erosion and landslides and allowing streams and rivers to flow clear.

The leaves, bark and wood of trees have been found to contain hundreds of compounds valuable to medicine and industry. Forests produce a wealth of useful species: oils, gums, resins, tannins, waxes, edible oils, dyes, cosmetics, spices, fruits, nuts and life•saving compounds used in medicine. Spices alone are worth more than $1 billion per year

(Schreiber *et al*. 1989). Medications derived from wild plants are worth $40 billion annually (Lean and Hinrichsen 1994). Painkillers, birth•control agents and malaria drugs, as well as quinine, digitalis and morphine, are all derived from tropical forest plants. According to one study, more than 40 percent of all prescriptions in the United States still depend on natural plant sources (Swaminathan 1990). Only a small percentage of wild plants have been tested for medicinal value. In some cases, plants that might have disappeared altogether were found to be medical treasures. The Madagascar periwinkle, native to an island which has lost 80 percent of its forests to deforestation, has been the source of two potent compounds that have proven effective in the treatment of Hodgkin's disease and produce a 99 percent remission in patients with acute lymphocytic leukemia (Myers 1983). Global sales of these two drugs now exceed $180 million a year (Wilson 1992). Taxol, a compound from the Pacific Yew found in the last of North America's old-growth forests, has proven effective against ovarian and other cancers.

In the long run, forests left standing are of greater benefit than those cut and destroyed. The dollar value of natural ecological systems, of which forests make up a large part, in performing services for human society has been estimated at as much as $54 trillion, as seen in Chapter 1 ("Earth's Worth" section). Along with their role in flood prevention and climate regulation, forests provide fruits and flowers to be pollinated by wild insects and birds, and clear rivers as habitat for valuable salmon and trout fisheries (Stevens 1997b). The World Resources Institute in Washington, DC, has calculated that the loss of value from deforestation is four times as high as the value of the timber extracted and the depletion of soils, forests and fisheries amounted to an average reduction of 25 to 30 percent in potential economic growth (Stevens 1997b).

The ways in which forests function are only beginning to be understood. Great fig trees are dependent on tiny wasps to complete their reproduction, and fungi in the roots of trees play intrinsic roles in their survival. Pollinators are key to the health of forests, but for many species of trees and plants, only fragmentary information has been acquired about how they are pollinated and the conservation status of these pollinators. Understanding the interrelationships of plants and animals within these ecosystems is key to their preservation, yet forest ecology is in its infancy.

While logic would seem to mandate that such awesome and useful ecosystems be accorded great respect and legal protection, the opposite is true. They are being destroyed so rapidly by logging, dams, climatic changes caused by human activity, and pollution that the last pristine forests may soon be gone. Even minor alterations in their environments have interfered with their healthy functioning.

Cutting forests for financial gain or to resettle people from overpopulated cities provides developing countries with short-term solutions to problems and one-time profits. Neither the extremely important ecological roles that forests play, nor their value as species storehouses, are appreciated by the majority of the world's nations. The recent spate of massive landslides and floods after periods of heavy rains in countries around the world has, in most cases, been traced to logging that left hillsides and entire regions open to erosion. Millions of people have been left homeless around the world in recent years, and thousands have lost their lives to such floods. These floods may be only a prelude to far more serious and long-lasting consequences of forest destruction. Global warming will increase as forests vanish, especially with the cutting of old-growth trees, which have immense canopies for absorbing carbon dioxide and cooling the atmosphere. Higher temperatures have already brought droughts, increased desertification and caused rivers and streams to lose volume and even dry up. The loss of potential disease cures is another byproduct of destroying forests, and the destruction of these beautiful environments, with their multitude of life forms, may result in collapsed ecosystems that cannot be restored.

Forests' Retreat

As recently as 1960, forests covered one•fourth of the Earth's land surface (CEQ 1980). With continued logging

and clearance, two decades later, in 1980, only one•fifth remained forested (CEQ 1980). Since then, forests have continued their decline, losing more than 5 million square miles since 1960. During the last quarter-century alone, the world's forests have shrunk the equivalent of one-half the land area of the United States.

This destruction has threatened thousands of animals and plants with extinction. In fact, forests have the greatest number of endangered species of any ecosystem. Of all types of forests, primary, old-growth forests, especially tropical rainforests, harbor the greatest wildlife and plant diversity and the greatest number of endangered species (Collar *et al*. 1994, Collins 1990, Mittermeier *et al.* 1999a). Second-growth and mixed types of forests are also key habitats for many species, and clearing these forests has threatened thousands of plants and animals.

Forests' Retreat: Page 1

Forest destruction is often gradual, a whittling away by settlers and farmers who destroy portions of forest to grow crops using fislash-and-burn,fl in which trees are cut, set afire, and the ashes are used as fertilizer for subsistence agriculture. In tropical forests, the thin soil is fertile for only a few years, and farmers move on to clear more forests. When human populations are very small, as in the case of the native peoples of many tropical forests, their effects are not severe or permanent, as the forest grows back. Non-indigenous people, however, often remove forest cover permanently**.** They do not think of the forest as a source of life, providing food and protection, as native peoples do. The entire center of the 1,000-mile-long island of Madagascar, once a verdant paradise with giant trees and teeming with wildlife, is now a moonscape as a result of such misuse of the land. Millions of rural people in developing countries now depend on wood cut in local forests for fuel. This has been another major factor in deforestation because of the growth of human populations spreading into new regions, cutting trees and clearing away vegetation.

In the Caribbean, Europe, eastern North America, North Africa and West Asia, most of the original forest cover was destroyed prior to modern times. These forests will not return once cut, nor will their diversity. The ecology and diversity of the forests that once covered much of Europe and the eastern United States will remain unknown because they were cut prior to any biological studies. We have only descriptions of giant trees and the wildlife that inhabited these forests. In the temperate rainforests of the Pacific Northwest, however, biologists are studying the last 5 percent that survives of these magnificent**,** old-growth forests. Working in the canopies hundreds of feet above the forest floor, they are making new discoveries about these ecosystems. They have learned that lichens colonize only the oldest forests and are key to fixing nitrogen (Moffett 1997), or converting this essential gas into compounds that can be used in forming life-sustaining amino acids and proteins (Franck and Brownstone 1992). One forestry student who climbed a 2,000-year-old Sequoia found cones growing only on the outer branches, which can remain on the tree for as long as two decades**;** a rich variety of lichens grow**s** on trunks and branches (Moffett 1997). Such discoveries illustrate the importance of preserving these ancient forests.

Only a little more than a century ago, rainforest and temperate old- growth forest covered millions of square miles

in West Africa, Central and South America, Southeast Asia, Australia and the western United States. Early settlers, followed by commercial loggers and large-scale livestock and agricultural interests, permanently destroyed these complex ecosystems. In some areas, second-growth forest or shrub has replaced them. Only in Amazonia, Central Africa, Russia and northern Canada do large tracts of virgin forest remain, and these are now being logged by international corporations.

Forests' Retreat: Page 2

A major use of timber is newsprint. Every Sunday edition of *The New York Times* consumes 75,000 trees (Bohan *et al*. 1996). Each issue of *Audubon* magazine, published by the National Audubon Society bimonthly, consumes 1,500 trees to make the 150 tons of glossy paper used to print 500,000 copies, according to its own research (Webster 2001). The trees used in the making of this paper were cut after 12 years by a mechanical harvesting machine that periodically clearcuts and replants with only one type of tree, creating an unnatural monoculture (Webster 2001). To remove the cellulose, chlorine is used, which releases .004 pounds of chlorine and chlorine gases into the air (Webster 2001), less than in the past but still an environmental threat. This organization, like many using large amounts of non-recycled paper, claims that the monocultures are teeming with wildlife (Webster 2001) and, by all appearances, does not consider other alternatives for the manufacture of its magazine. Other magazines, such as *National Geographic*, also use unrecycled, glossy paper. By contrast, The Nature Conservancy decided in the 1990s to abandon use of virgin paper for their magazine, even if it meant a less glossy finish, and now prints on recycled paper. Many other conservation organizations have followed suit.

Tropical woods are also used to manufacture paper. With conservation and recycling by consumers in North America, Europe and Japan, no tropical forest trees would need to be cut for paper. The majority of newspaper used in the United States, which is the world™s largest consumer of paper, is thrown into landfills or burned (Bohan *et al.* 1996). Many tree-based products, from shipping crates to plywood and paper, could be made from other materials, both non-wood and re-used wood. Corporations feed a market hungry for inexpensive raw material. The trees are sold for almost nothing by the countries of origin, resulting in high profit margins for logging companies.

Forests' Retreat: Page 3

In the year 1500, tropical forests covered continental and island areas totaling 5.5 million square miles (Collins 1990). Today, only a fraction of this extraordinarily rich ecosystem remains. The estimates of loss vary. Some scientists count only the acreage of untouched pristine rainforest in their estimates, while others include various types of tropical forests, second-growth and disturbed forests. Satellite images, combined with aerial photography and ground surveys, are giving an ever more detailed and accurate picture of the decline of these irreplaceable forests. One reference, *The Last Rainforests*, edited by Mark Collins (1990), calculated that in 1990, only 3.3 million square miles of tropical forest remained in the world. It estimated that about 54,000 square miles were being cleared worldwide every year (Collins 1990). This authority concluded that 50 percent of all tropical forests had been lost since 1900 (Collins 1990). In the disastrous decade of the 1990s, as much as half of the remaining tropical forests were cut or burned. Although estimates of loss vary, there is general agreement that dramatic losses occurred in many parts of the world during the 20th century.

This destruction is taking place at a catastrophic rate. According to Dr. Edward O. Wilson of Harvard University, an expert in biodiversity and tropical forests, the surviving tropical forests equal the lower 48 US states in area, and a region the size of Florida is disappearing each year. The Nature Conservancy (2000) estimates that 40 million acres of tropical forests disappear every year. Settlers in many tropical forests have traditionally practiced slash-and-burn.

The soil is so thin that it becomes sterile after a few years of farming, and the farmers move on, cutting more forest. Such practices whittle away at forests, but when carried out only by small bands of natives, these cut-over acres tend to recover in time. In many areas, however, European settlers have cleared land in this manner and fertilized the soil, maintaining it as agricultural land or depleting it so severely that the forest can never grow back.

Forests' Retreat: Page 4

Cambodia's last expanses of tropical forest are being lost in a pattern typical of many countries. Intensive logging during the past 50 years has reduced forest cover in this country from 70 percent to only 35 percent (Mydans 1996b). In spite of a logging ban instituted in January 1996 and a ban on exporting logs set in place in April 1995, the country's two Prime Ministers signed secret concessions to sell off virtually all of Cambodia's remaining forests (Mydans 1996b). The ancient teak forests are being openly felled, with logs exported to neighboring countries for profits of $10 to $20 million per month and in spite of official pledges to stop this logging (Mydans 1996b). Elephants are used to haul the logs across rough terrain, and many are abused with drugs to keep them working and overloaded, causing serious injuries or death. Some have been maimed or killed by stepping on land mines. Armed guards protect these loggers and sawmill operators; regional forestry officials, who oppose the cutting, are unequipped to confront them (Mydans 1996b). Already, siltation, erosion, flooding, and destruction of agricultural fields have resulted, and Cambodia's King Norodom Sihanouk, who appears helpless to stop this situation, commented, "If this deforestation does not stop, Cambodia will be, alas, a desert country in the 21st century" (Mydans 1996b).

Asian logging companies have now turned to the pristine forests of Belize, the only sizeable forests remaining in Central America. In 1997, the government of Belize sold logging rights to Atlantic Industries, a Malaysian company, for $60 an acre to clearcut in primary, old-growth rainforest**,** principally for mahogany (Hecker 1997). The company logged in areas outside the agreed-upon area and leveled large numbers of Sapodilla trees, the source of chicle that can be tapped sustainably (Hecker 1997). The deforestation of Central America has been most extreme in El Salvador, Nicaragua and Costa Rica (Collins 1990, Harcourt and Sayer 1996). Fires set by settlers and business interests creating plantations for palm oil and tree farms, burned out of control in the late 1990s in Borneo, Sumatra, Bolivia and Brazil, destroying many ancient forests, including some in national parks.

Secret agreements between various government leaders and international logging corporations or with friends and relatives, for logging rights over large sections of forest are commonplace in many countries. Indonesia and Malaysia, for example, encourage destructive clearcuts in which conservation is not a concern, and fast-paced logging is carried out because the agreements may be negated by a change in government officials (Yates 1992). The largest remaining rainforest in West Africa, a 2.5-million-acre swath in Liberia, is being logged by a Hong Kong timber company as a result of a large bribe paid to the brother of Charles Taylor, the newly elected President of the country (Farah 2001). Such bartering away of the world's greatest treasure-houses of biological diversity is a travesty that will adversely affect the Earth's stability and the lives of many generations of people in the future. Lost will be magnificent ecosystems containing plants and animals not even discovered.

Corporate logging has emerged as the major cause of tropical forest destruction, greater even than the losses to settlers and agriculture. This logging is carried on without international controls and with inadequate national controls. This industry grows each year, and the international trade in wood, pulp and paper is now worth about $100 billion per year, making timber the third most valuable natural resource (Bohan *et al*. 1996). Of this total, a large percentage is timber from tropical forests. By the mid-1990s, scientists estimated that some 80 percent of Southeast Asia's--and a similar percentage of West African and Madagascar's--forests had been destroyed. An in-depth study of corporate logging by the Environmental Investigation Agency (EIA) estimated total sales of one of the largest corporations, Mitsubishi, at $5.3 billion in 1995, controlling a total land area of 9 million hectares (22.2 million acres) (Bohan *et al*. 1996). Mitsubishi's plywood mill in the Brazilian Amazon consumes 130,000 cubic meters of logs every

year through the intensive and unregulated harvest of virola trees (Bohan *et al*. 1996). About 75 percent of all tropical forest trees is turned into plywood for disposable packing crates, construction and furniture, according to the Rainforest Action Network (RAN) of San Francisco, California (RAN 1993). The United States alone imports several hundred million pallets of tropical hardwood each year and throws them away after a single use (Revkin 1997).

Forests' Retreat: Page 5

The promotion of a commercial approach to old-growth tropical rainforests, even "sustainable yield," is based on fragmentary and inadequate knowledge of these ecosystems. It is not known with certainty that their trees can be harvested without harm. Sustained yield forestry concerns prevention of the extinction of various tree species by controlling harvest and, to a lesser extent, protecting of watershed and soil, but not necessarily ecosystem protection. Maintaining the complex web of plants and animals that form a forest should be the prime consideration in conservation. To this end, protection from harm is the logical approach until these ecosystems are properly understood. Their ecological value will only be measurable as knowledge about their functioning and their role in the world's climate are explored in the future. In economic terms, they have great potential as tourist attractions, and the new videocam Internet business, as described in the Focus on Indonesia section below, will likely far outproduce short-term income from timber or conversion to agriculture.

An indication of the effects of this destruction is the fact that 76 percent of the 1,186 birds in higher categories of threat, or 902 species, are forest•dwellers, according to *Threatened Birds of the World*, a comprehensive report by BirdLife International, which examines bird status for the *Red Lists of Threatened Species* published by the International Union for the Conservation of Nature (IUCN) (BI 2000). All these birds are in danger of extinction. Some, such as the 182 Critical species, are in imminent danger of becoming extinct. Of the 902 forest birds, 93 percent are native to tropical forests; of these, 41 percent are found in lowland forests and 36 percent in montane moist forests, such as cloud forests (BI 2000). Three-fourths of threatened forest birds are dependent on a particular type of forest, and almost half require near-pristine habitat, with little or no disturbance, or habitat degradation (BI 2000). Only 3 percent of threatened forest birds can tolerate habitat modification. Unsustainable selective logging affects 367 forest bird species, while other threats include clearing forests for small farms (24 percent), tree plantations, clearcutting forest, livestock grazing, cutting trees for firewood, mining in forests and human settlements (BI 2000). An additional 727 bird species are classified as Near-threatened or close to qualifying as Threatened.

Likewise, forests are the major habitat for threatened mammals. The IUCN assigned habitat types to 515 (46 percent) of threatened mammals, finding that about 75 percent inhabited tropical rainforest; of these species, 35 percent in lowland and about 22 percent in montane (Hilton-Taylor 2000). (Some mammals may occupy more than one habitat). Tropical dry forest accounts for another 15 percent; tropical degraded forest, 4 percent; and tropical savannah woodland about 5 percent of threatened mammal habitats. By comparison, temperate broadleaf forest is the habitat for some 4 percent; and coniferous forests, 5 percent of threatened mammals (Hilton-Taylor 2000). The vast majority of threatened frogs and toads are also native to tropical forests.

Many species of tropical trees have been driven to extinction by habitat destruction and the exotic wood trade. The majority of Caribbean islands, which were covered in tropical rainforests when Europeans first saw them in the late 15th century, are now barren. A species of mahogany native to the Caribbean (*Swietenia mahogani*) has been so heavily exploited that no unstunted specimen remains. Elsewhere, once common species of forest plants and animals have been eliminated or endangered. Where habitats were limited on islands such as Hawaii and Mauritius, fragrant sandalwoods and other trees were cleared, and few--if any--specimens remain of the trees that once made up these forests.

Forests' Retreat: Page 6

The Rainforest Action Network has documented that 140,000 mahogany trees are being logged annually, with each tree worth about $1,500 wholesale in the United States, where most are marketed (Line 1996). RAN states that most of the mahogany trees in trade have been illegally logged from parks, conservation areas or other protected lands, causing ecological damage on a large scale.

Mahogany takes 40 years to reach harvestable size, and the majority of this wood that is traded internationally comes from wild harvested trees. Many tropical species have reached commercial extinction, and Honduran Mahogany, which grows to 130 feet with a massive canopy, is the major target of the logging industry in Central America. By having a market for mahogany, especially a lucrative one, loggers seek out these trees, even in protected national parks. Once in commerce, distinguishing legal from illegal becomes impossible.

Trees that are commercially valuable are often the very ones most important to wildlife for food sources or shelter. The largest and oldest trees produce the greatest profits and are the first to be cut. These trees provide nest holes for owls, toucans, hornbills, parrots, tiny monkeys, lorises and galagos, rare lemurs, and countless other wildlife species. Many species of wildlife use tree holes for shelter year-round. Although some birds, such as woodpeckers, can excavate nest holes, the majority of animals who shelter and nest in tree holes depend on natural cavities. These holes form when tree limbs fall off or from rotting within tree trunks. Research on wild macaws has determined that a lack of trees with nest holes plays a major role in limiting their populations. Macaws nest only in large cavities very high, usually 100 feet or more, in tall tropical trees. Only the oldest and largest trees have tree holes for the more sizeable animals, such as hornbills, macaws and families of small primates who den together.

The Harpy Eagle (*Harpia harpyja*), the world's largest eagle, is endangered in its neotropical rainforests. Its range once extended unbroken from southern Mexico through the Amazon but today it is rare or absent throughout the remaining forests. A major factor in its decline is logging of the tall, old trees it requires for nesting. These eagles need a high vantage point overlooking the treetops to spot prey and to prevent predation on their nests. Harpy Eagle chicks have a long period of fledging, and prior to their independence, they must strengthen their leg and wing muscles. Eagle parents always make their massive nests near the top of giant trees with wide branches near the nest where the chicks can exercise by running across the branches, flapping their wings. As the strongest avian predators in these forests, they must be able to kill animals as large as sloths and carry them off in their talons. Loggers spot these giant trees rising over the forest canopy and cut them for the enormous amount of wood they contain. In much of Central America, selective logging and clearcutting have destroyed many of the former haunts of this magnificent bird.

Dead trees still standing are also prime wildlife nests and shelters, but because they are considered fire hazards, they are cut routinely. Hollow limbs and fallen logs are used by many types of animals for shelter or nesting, and these are usually trimmed off by loggers. Rotting tree trunks and cavities in both standing and fallen trees support entire communities of insects and invertebrates, upon which many vertebrates depend for food, and which contribute to the forest's health.

Modern loggers use mechanized tools and machines to clearcut forests. Chainsaws can cut through the massive trunk of a thousand-year-old tree in minutes. For smaller trees, saws mounted on trucks slice their trunks like matchsticks, and machines lift the trunks onto logging trucks for transport, trimming off side limbs in the process. Every tree in a forest, ancient or young, commercially valuable or cut only to be discarded, is logged. Forests covering 1,000 square kilometers have been completely denuded in a single clearcut. Huge processing trucks sweep through the forests, creating deep ruts in the forest floor. Roads are bulldozed for this logging, opening up forests,

causing erosion to soils and flattening fragile plants. Baby birds, squirrels, bats and tiny primates in tree holes are killed as their homes are sent crashing to the ground and dragged along the forest floor.

Forests' Retreat: Page 7

Kitt Chubb, a Canadian wildlife rescuer, recounted the trauma that one family of owls endured as a result of a mechanical logging operation. Tiny Screech Owl (*Otus asia*) chicks, still downy and being fed in their treehole nest by the parents, suddenly found themselves slammed to the ground when the tree was cut. A giant logskidder machine roared through the woods gathering up the cut trees, including the one containing the owl chicks (Chubb 1995). The machine proceeded through the woods, bouncing and violently rocking over rocks and ruts. This cacophony must have terrified the owl chicks. Finally, the driver dumped the trees with a crash onto a pasture (Chubb 1995). Soon after, an employee with a chain saw began to cut up the trunks, and as he cut into a big knothole, he jerked the saw back when he saw three fuzzy grey owl chicks with their eyes closed tight (Chubb 1995). Amazingly, they had not been injured or killed after being knocked and bounced about. The loggers decided to save the little Screech Owls, bringing them to Chubb's wildlife rescue center. She placed them in a wooden box and returned with the box the next day to the spot where their nest tree had stood. The forest where the owls had lived had been obliterated, and not a single tree remained. Finding a hollow beech stump in the clearcut not too far away, she and fellow rescuers placed the box in the stump, covering the top with leafy branches for shade, hoping the parents would return to feed the chicks (Chubb 1995). The next day, Chubb was surprised to find a frog leg in the box with the chicks, left by a parent owl. The chicks were lively and vocalizing, and 10 days later, they were still healthy and ready to be banded (Chubb 1995). Unfortunately, few baby birds and other animals survive logging operations or are lucky enough to be rescued if found alive.

Even animals as large as bears are frequently killed when they den in large tree holes. If their cubs survive, they will die of starvation if not rescued. Numerous cases of logging operations orphaning or causing mothers to abandon bear cubs are documented each year. A National Geographic Society film, fiMother Bear Man,fl shown in 1998 on "National Geographic Explorer," told the story of three bear cubs found after logging operations and their long return to the wild under the care of a kind and experienced wildlife rehabilitator in New England. Turtles, rodents, snakes and ground birds sheltering in burrows can be crushed to death by heavy logging machines. The soil, no longer held in place by root systems, breaks loose when saturated by heavy rains. Severe erosion on hillsides can cause mud slides that swallow up houses and the forest below, leaving a virtual moonscape, devoid of life. On level areas, rain washes soil into streams and rivers, clogging them, which kills fish and other aquatic lifeforms. Beautiful tropical forests with 300 or more species of trees per acre, a typical diversity, and myriad species of birds, mammals, reptiles, amphibians and invertebrates inhabiting them, become denuded patches of bare soil interspersed with stumps and broken limbs after clearcutting.

Even in remote wildernesses, the heavy machines that are now used to harvest and transport trees create such havoc and noise that wildlife flees. Many species of rare primates and birds disappear from logged forests, unable to adapt to any logging activities. A recent study in Gabon found that selective logging operations so traumatized Chimpanzees (*Pan troglodytes*) that their population in one 2,000-square-mile reserve fell by 80 percent after logging, even though only 10 percent of the trees were cut (Stevens 1997a). Dr. Lee White, a biologist with the Wildlife Conservation Society in New York, who was studying these Chimpanzees, made the following observation when loggers were in the forest: "I had whole chimpanzee communities charging to about five meters and screaming at me, and that's very unusual behavior" (Stevens 1997a). They were observed in logging areas in extremely agitated states, drumming on trees and calling to each other. The tremendous noise and disturbance by large machines apparently caused them to flee into the territory of neighboring Chimpanzees, where they fought to the death (Stevens 1997a). Both the Chimpanzee and Bonobo, or Pygmy Chimpanzee (*Pan paniscus*), are endangered species, and the latter is unlikely to survive much longer in the wild as a result of logging. Its tiny population inhabits a restricted portion of

forest in the Democratic Republic of the Congo, the former Zaire. Both are also killed in large numbers for meat markets by loggers and hunters, who use logging roads to enter forests. The traumatized orphaned young are sold as pets and to others who exploit them commercially.

Forests' Retreat: Page 8

Many of the last old-growth forests have been cut for throwaway products such as shipping crates, concrete forms, plywood, chopsticks and newsprint. Virgin rainforests in southeast Asia, Australia, Alaska, Russia and British Columbia are being logged to supply the enormous demand for such products, destroying entire ecosystems in the process. The United States and Japan have played major roles in the logging and trading of lumber at extremely low prices for industrial uses (Yates 1992). When one country's forests are stripped, loggers move on to another. In this way, the great Philippine forests of Pliocene trees and Central American forests were cut in the mid-20th century, followed by the teak forests of Thailand and the hardwoods of Indonesia and West Africa. These areas have lost 80 percent or more of their forest cover, and loggers have now moved on to Central Africa, Burma, Belize and Amazonian South America. Brazil's beautiful rosewood trees have already been logged to near extinction. The World Conservation Monitoring Centre of Cambridge, UK, conducted a study on commercial logging and found that 304 tree species from Asia and Africa were threatened with extinction by trade (Bohan *et al.* 1996). Fifteen species of commercially logged trees are listed by the Convention on International Trade in Endangered Species (CITES) in the most endangered category.

In response to criticism about clearcutting, some logging companies and conservation organizations endorse selective cutting, or cutting only certain species of trees or trees of a certain age. Yet such logging is also destructive. One United Nations (UN) Food and Agriculture Organization (FAO) study found that selective cutting destroyed as much as 70 percent of forest cover when conducted totally irresponsibly and, on average, destroyed 30 to 40 percent of the trees (Bohan *et al*. 1996). Destruction of non-target trees occurs with the construction of logging roads and use of heavy equipment to extract trees; when tree canopies and vines entangle one another, many trees are brought down, although only one may be cut. A study in French Guiana found that an average of 57 trees are killed for every tree extracted by selective logging (Bohan *et al*. 1996). Research on logging in Sarawak, a Malaysian state on Borneo, found that of every 26 old-growth trees cut, 33 others were destroyed or damaged, and canopies were broken, isolating animals who will not cross open spaces (Yates 1992). The thin tropical soil was also compacted and exposed, preventing natural regeneration of the forest (Yates 1992).

Many logging companies claim that by cutting mature trees selectively on 30- to 70-year rotations, they are conserving forests (Collins 1990). By definition, no tree older than 70 years can exist in such a forest. Such logging will end in destruction of the ancient and diverse forests, with trees 1,000 or more years old harboring a wealth of species that can only grow and prosper in old-growth forests. The more diverse a forest, the more stable ecologically, and logging tends to impoverish diversity by selectively removing certain commercially valuable species.

Thousands--and perhaps millions--of species depend on primary, virgin forests and cannot adjust to second-growth or logged forests. How many, and which species they are, however, is only partially known. Even scientists specializing in forest wildlife have not determined all the species that fall into this category, especially in complex tropical forest ecosystems. Unfortunately, this knowledge is often acquired too late, after logging has taken place and endemic species have disappeared. Logging operations are proceeding with such speed, and the scientists chronicling the damage are so few in number, that in terms of threats to plants and wildlife, only the tip of the iceberg is being documented.

Forests' Retreat: Page 9

Until the 1970s, no one knew what the effects of clearcutting forests would be on various species of rainforest wildlife. The US government's Smithsonian Institution, with ornithologist Dr. Thomas Lovejoy supervising, conducted the first scientific studies of the effects of forest destruction in the Amazon on a wide range of wildlife. Blocks of interior forest of various sizes were inventoried by teams of biologists with mist nets and live animal traps. After each inventory was completed, the blocks were isolated by clearcutting the forests surrounding them. Then, after a period, they were inventoried again to discover the effects of clearcutting on the wildlife in the newly isolated forest patches. This type of research aims to discover how large reserves must be to preserve the diversity of ecosystems.

The results of Lovejoy's research in Amazonian primary forest indicated that small reserves of 2.5 acres or less lose a large percentage of their wildlife, and the larger the reserve, the fewer the number of species that disappear (Lovejoy *et al.* 1984). Certain species are dependent on large areas of primary, old-growth forest and are quick to disappear as soon as forests are disturbed or fragmented. Bird populations tended to decline in most reserve sizes, and species composition changed. In the smallest plot, 39 species of birds dwindled to 18 species after three years, and in the larger plot of 25 acres, 48 species declined to 38 (Lovejoy *et al.* 1984). The understory species were censused, as opposed to the canopy birds which seem less vulnerable to fragmentation of forest. Ecological dependencies caused some extinctions. For example, army ants thrive in large areas but disappear from smaller ones, and birds that feed on these ants, such as antbirds which are diverse and numerous in primary forests, disappeared within a short period from smaller plots (Lovejoy *et al*. 1984).

In another chain reaction, the White-lipped Peccary (*Tayassu albirostris*) proved to be a keystone forest species. It digs small waterholes to wallow in when ponds dry up, providing habitat for other wildlife. Peccaries travel in large groups seeking their diet of fruits, especially palm fruits, and act as seed dispersers. The key to their survival is territory size: a herd of 100 animals requires a territory of 97 square miles (Fragoso and Silvius 1995). They disappear from smaller forests causing the local extinction of frogs, who lay their eggs in these waterholes. In the Amazon study, four species of frogs disappeared from areas where peccaries had insufficient habitat to survive (Lovejoy *et al*. 1984).

Many other mammals are affected by forest fragmentation. Twenty species of mammals occupied a large, undisturbed forest plot, while only five were left in an isolated 25-acre-forest; a mere three mammal species remained in a 2.5-acre-forest (Lovejoy *et al*. 1984).

Theoretically, extinctions also can be caused when species have limited distributions which are destroyed by logging. A number of birds and mammals, including several newly discovered marmoset species in the upper Amazon forests, inhabit extremely restricted ranges of only a few square miles. Some species of primates will refuse to cross a road, such as a logging road, or an open clearing. Should a road be built in the middle of their tiny ranges, they would face extinction. Since tropical forests have not been thoroughly inventoried, the endemic species at risk most probably number in the tens of thousands.

Butterflies that live only in deep, virgin rainforest are so intolerant of fragmented forest that they disappear from areas less than 250 acres and, even there, survive only in the central core area (Laurance and Bierregaard 1997, Lovejoy *et al.* 1984). Forest butterflies, which exist in amazing diversity, are highly sensitive to the disappearance of their host plants, upon which they lay their eggs, and thrive in greatest number when vegetation is highly diverse. Some cannot tolerate the penetration of light into forests, and others require such large territories to feed that they disappear from small reserves, according to research by Keith Brown and Roger Hutchings (Laurance and Bierregaard

1997).

In small forest blocks, trees on the forest edge become vulnerable to the effects of wind and fire, fall in far greater numbers than those in the center and succumb to fires that spread from neighboring grasslands. Fires consumed large areas of rainforest in the Amazon during the late 1990s as a result of fragmentation. This was the first record of rainforest fires in this region. Storms blow down trees adjacent to the edges of fragmented forests and, over a period, will destroy the inner primary forest (Lovejoy *et al.* 1984).

Research on forest fragmentation is now taking place in Africa, Asia, Australia, the Indian Ocean islands and elsewhere in the world. Numerous scientific papers on the subject were gathered in a book entitled *Tropical Forest Remnants. Ecology, Management, and Conservation of Fragmented Communities* (Laurance and Bierregaard 1997). Many of these studies paint a grim picture of the effects of forest fragmentation on biodiversity.

Bats are important forest pollinators but are extremely vulnerable to extinction. They are rarely protected and often persecuted. The valuable Durian fruit of Asia is one such plant pollinated by a declining species of rainforest bat. Other food plants pollinated by bats include wild bananas, breadfruit, mangoes, guavas, avocados, almonds, cashews and cloves, according to Bat Conservation International, which is dedicated to changing the negative image of bats and preserving wild populations (see Organizations list for address).

Forests' Retreat: Page 10

Throughout the world, biologically diverse natural forests are being replaced with tree farms of fast-growing pine or eucalyptus. In Japan, cedar is planted over millions of acres for harvesting. The goal of these farms is to replace old-growth forests that take hundreds of years to mature with trees that can be harvested in 30 to 50 years. Large amounts of herbicides and pesticides are applied to prevent the growth of "undesirable" plants and to control insects. These tree farms have contaminated water tables, destroyed natural diversity, and eliminated countless life forms crucial to maintaining the ecological balance of the planet. Moreover, many are now failing even in their goal of producing fast-growing, healthy trees because of a lack of understanding of ecological systems and natural forest functioning. Tree farms are frequently swept by disease and, in the case of Japan's cedar plantations, which cover 10 million acres, shallow roots have resulted in trees blown over in windstorms and landslides after heavy rains. A healthy forest has many species of trees. This diversity discourages insect pests, which tend to specialize in individual species, from spreading and sweeping through the forest, killing all the trees. The variety of trees in a natural forest also means that many are deep-rooted or have root mats that anchor the soil from erosion.

An added environmental threat posed by tree farms is the use of genetically engineered seedlings, whose effects on ecosystems are not yet known. By transplanting genes from other species of trees--and even animals-- into these unnatural trees, the possibility that their seeds could spread to the wild and contaminate natural trees and plants is very real.

Major disruptions in pollination occur in fragmented forests. Natural tropical forests, with hundreds or even thousands of species of trees, have evolved complex systems of reproduction. Because other trees of the same species might be miles away, trees send their pollen far and wide. Insect pollinators travel great distances to find trees of the same species. Biologists have found that even in selectively logged forests, trees were not being pollinated naturally because others of their kind were removed or became too distant; some species self-pollinated, causing in-breeding, while others simply died out (Yoon 1995b). These biologists concluded, "Even the forests that appear the healthiest but are being selectively logged or otherwise thinned may be endangered in the long run by an increase in less desirable inbred seed" (Yoon 1995). Inbred stock usually loses vigor and ability to reproduce over the long run. This is an ominous finding considering that many conservation organizations and international logging companies have

endorsed certain "sustainable" logging programs, urging the public to purchase products identified as such. Moreover, many of these ancient trees tower 200 or more feet, with wide buttresses at ground level to anchor them in the thin tropical soil. Such trees may have stood on the forest floor for 1,000 years and are living monuments, treasures to be preserved, not raw material for packing cartons, furniture or paper pulp.

Preserving Forests

A 10-year mapping project by the World Conservation Monitoring Centre ending in 1996 found that only about 6 percent of the world's remaining forests are protected against logging and development. Because of the rate of destruction and the potential loss of biological diversity, this is an extremely critical situation.

Preserving Forests: Page 1

Much of the logging in the world is a result of markets provided in the United States, Japan and Europe for wood and wood products. Because paper pulp is cheap, there is little effort to find substitutes or even to recycle the millions of tons of paper thrown into landfills each year. The use of trees for making paper is government-subsidized, encouraging waste and destruction of forests. Tree farms have failed to meet the enormous demand for paper. Financial incentives to recycle or use other materials should be made by consuming countries. Finding substitutes for lumber and raw material for paper will be crucial in protecting entire forests. The United States imports 800 million pounds of paper from Brazil every year, to the detriment of that country's forests. In spite of computers and Internet communications, total amounts of paper used in the United States have not decreased; 4.3 million tons of paper are used in US offices alone each year, and millions more tons are used in newsprint, magazines and other paper products. Because of a lack of economic incentive, only a small portion of this paper is being recycled into new paper. In fact, studies of landfills have shown that 40 percent of material in these dumps consists of unrecycled newspapers.

Innovative approaches are needed to encourage recycling and to end subsidies and the importation of wood chips and newsprint from forests around the world. Some of the alternatives to paper made from wood are already in use. Thousands of years ago, Egyptians produced paper from papyrus reeds, and rice is still used to make paper in parts of East Asia. Cotton and flax are the raw materials of fine quality paper used for currency and other purposes.

Many other plant species are now seen as substitutes for wood pulp in making paper. In *A Wealth of Wild Species, Storehouse for Human Welfare*, Norman Myers (1983) mentions one of these, a plant called kenaf, that is a distant relative of cotton and okra. This plant has been cultivated for centuries in Asia for making burlap bags. A fast-growing, reed-like plant, kenaf shows great potential in the manufacture of paper. Its straight, slender stem has no side-stems, nor does it produce the kind of resins that must be eliminated when wood pulp is processed for paper. Planted like corn, it is ready for harvesting in four months and produces five times more pulp per acre than a pine tree plantation (Myers 1983). In research conducted by the US Department of Agriculture, kenaf has proven an excellent substitute for paper in newspapers and even bank notes (Myers 1983). A few kenaf farms have been established

without government sponsorship in Texas and other southern states, and already many organizations are printing newsletters using kenaf instead of wood-based paper. Processing kenaf does not involve the serious water pollution caused when cellulose is removed from wood and pulp is bleached with chlorine. Air pollution from wood pulp processing plants has been injurious to human health (Verhovek 2000).

Earth Island Institute of San Francisco, California, has published a report, *Forest Friendly Paper Guide*, giving more information on kenaf and other non-tree substitutes for paper, including a new paper product by Arboken of Canada that is made from wheat straw, recycled corrugated cardboard and calcium carbonate filler. A publication called *Guide to Environmentally Sound Papers*, issued by an organization called Conservatree, lists more than 400 types of "green" paper. Among these are recycled, kenaf-based, hemp, sugarbeet and corn, grass and crop waste paper. (These can be obtained from Earth Island Institute. See the list of organizations in this book for the address.)

Preserving Forests: Page 2

Most homes are constructed of wood. An average of 40 to 50 trees are needed to build a 2,000-square-foot wood-framed house (Bielski 1996). Building with stronger materials, such as steel, concrete, brick and stone, would spare millions of trees. Moreover, these materials are not vulnerable to infestations by termites, which destroy entire foundations and frameworks of buildings made of wood. To control these insects, pest control companies apply large quantities of extremely toxic pesticides that can leach into the soil and water table, killing wildlife, and pose hazards to the occupants of the house. The Institute of Ecolonomics in Ridgeway, Colorado, reports that a new tree-free "wood" has been developed for use as building material. Called BioComp, it contains half recycled plastic and half agricultural residue and, according to the Institute, is twice as strong as Douglas Fir, termite-proof, impervious to water, and can be made fire retardant. BioComp resembles wood and is easily molded, sawed and nailed. Some alternatives to wood are also less expensive. Steel is being used in New England homes for major support beams with a metal roof for less money than the same home would cost made of wood (Hotton 2001).

The Wood Reduction Clearinghouse has been formed in San Francisco to address the failure of considering consumption as a driving force in deforestation (Bielski 1996). A group of leading environmentalists issued a statement in 1995 calling for a 75 percent reduction in wood and paper use by 2025, and strategies for eliminating the need for wood altogether are being explored (Bielski 1996). The use of timber for shipping crates and concrete molds--especially tropical hardwoods--should be phased out and substitutes, such as plastics, phased in that would be more economical because they could be reused. Some stores are already using substitutes for the millions of cardboard cartons used to ship goods.

Preserving Forests: Page 3

At the 1992 "Earth Summit" in Rio de Janeiro, Brazil, convened by the United Nations Conference on Environment and Development, world leaders agreed on the importance of slowing the rate of global forest destruction. Conservationists have pressed for a new, legally binding Global Forest Agreement to conserve and manage the world's forests. In spite of the urgent need for such an international treaty, no agreement has been reached in the intervening years. Numerous meetings and conferences between nations have failed to draft a policy that would curtail the uncontrolled commercial logging that is ravaging forests around the world.

Several organizations, including the Environmental Investigation Agency (EIA), headquartered in London, and the World Resources Institute (WRI) of Washington, DC, have issued reports that chronicle the damage being done and

the need for such a treaty. EIA's report, *Corporate Power, Corruption & The Destruction of the World's Forests, The Case for a New Global Forest Agreement*, argues for the need for international agreements to control commercial logging (Bohan et al. 1996). This report gives detailed information on the companies doing the most environmental damage to the world's forests and the methods used by these corporations to bribe and otherwise corrupt the leaders of poor nations to obtain logging contracts. Other organizations, such as the Rainforest Action Network, agree that international logging corporations must be regulated. This $100-billion-a-year trade operates with generous tax breaks from the countries where companies are based and the granting of logging concessions that often cover millions of acres through special arrangements made behind closed doors with government officials (Bohan *et al.* 1996). Logging concessions almost always ignore or overrule strict legislation already existing in many countries protecting the environment and wildlife, including endangered species (Bohan *et al.* 1996).

At present, cutting of forests is "regulated" only by the timber industry itself through the Tropical Timber Agreement, signed in 1983 by various international lumber companies. This agreement does not protect wildlife and the environment. In spite of renegotiation in the mid-1990s, the agreement still does not address ecological concerns or species preservation. Pressure from multi-national companies, primarily Japanese, to supply this lucrative market have overwhelmed the voices of conservationists throughout the world.

Logging in Central Africa is in the process of destroying the once vast and unspoiled forests. A conference in 1999 was convened by the World Wildlife Fund (WWF) to reach an agreement about the fate of these large tracts of tropical rainforest in Africa, located in Cameroon, Central African Republic, Gabon, the new Democratic Republic of the Congo, Equatorial Guinea and the Congo. In this region, 40,000 square kilometers of forest are being destroyed a year, endangering hundreds of wildlife species and opening up the forest to a devastating trade in bushmeat. Prince Philip, in speaking on behalf of WWF, stated that the organization hoped to protect 10 percent of this vast forest, an area too small to prevent extinctions and great biodiversity loss. The Democratic Republic of the Congo, which is in a state of political chaos, did not attend the conference, and no pact was signed.

Preserving Forests: Page 4

The forests of the Democratic Republic of the Congo are among the wildest and least explored in the world, but this wilderness is being invaded by loggers and meat hunters. Michael Fay, a biologist with the Wildlife Conservation Society in New York, has been on a mission to cross this vast area on foot, accompanied by some natives and correspondents, describing the amazing sights along the way. He is trying to draw attention to this region and the urgency of saving it while most of it is still in pristine condition. He has already succeeded in having a sizeable national park established. His trek is dangerous, with poisonous snakes, leeches, tropical diseases and other threats, but he is a dedicated conservationist and scoffs at the dangers. The National Geographic Society is helping to sponsor his trip and publishes regular articles in their magazine on his progress, and their website gives more information. Several short films have also been made for the National Geographic fiExplorerfl program. His mission is extremely important and has the potential of preserving entire ecosystems of threatened animals and plants.

A growing awareness of the problem, along with creative solutions, give hope that in at least some parts of the world, large tracts of tropical forests and their wildlife will be spared. Two enormous parks were established in Suriname and Bolivia in the 1990s, mainly as a result of the work of Conservation International, a US organization that successfully convinced the governments of these countries that such protection will be far more beneficial for the country than short-term exploitation and forest clearance. Other organizations are working effectively in central Africa, Peru, Brazil, Burma, Laos, Vietnam, and the Philippines to protect these species-rich forests.

New approaches to deriving funds from forests without logging and destroying diversity include regulated extraction of non-wood products, such as seeds, fruits and plants, for food and medicinal purposes. Ecotourism is one

of the most lucrative and growing industries in the world, with revenues in the billions of dollars and rising.

Old-growth forests are being cut not because they provide raw material that cannot be found elsewhere, but because they provide a high profit margin to European, North American and Asian logging companies. Decisions made about the fate of these forests, upon which the survival of so many species depends, are not being made by the people where logging takes place, nor by conservationists. These precious and irreplaceable resources, habitat of the majority of the world's threatened species, are being sold to logging companies for pittances. The United Nations has recently endorsed the concept that forest diversity must be maintained, joining the ranks of many other international organizations. In time, society may learn to preserve these storehouses of evolution with the same zeal that great works of art are protected.

Preserving Forests: Page 5

One project has greatly improved the standard of living for villagers in India, while taking steps toward protecting the forest habitat of the highly endangered Bengal Tiger. Many thousands of residents were forced to move when Ranthambhore National Park was established decades ago, causing much resentment. At first, they were banned from gathering firewood and grazing livestock within the park. This had an extremely positive effect on the forests, which regenerated, and Tigers, deer and other wildlife prospered. Gradually, however, park authorities became more tolerant of the incursions of local people and their livestock into the forests. During the 1980s, large areas became deforested, and poaching endangered Tigers and deer within the park.

To reverse this trend and preserve the habitat of this park's wildlife, a Tiger conservationist and author, Valmik Thapar, established the Ranthambhore Foundation. This Foundation sponsored a nursery which propagated 500,000 tree seedlings, employing villagers to replant the national park. It set up a farm with domestic buffalo which had been bred with milk cows and kept in stalls and enclosures away from the forests. These animals yield far more milk than the emaciated Indian cows overgrazing the forests; fuel for cooking and heating is provided by a bio-gas plant producing methane from the buffalo's dung; a new crafts industry employs women in the village (Ward and Ward 1993). In the first four years of the project, 6,000 school children from local areas were taken into Ranthambhore National Park for education programs (Currey 1996).

A Cable News Network (CNN) reporter, Gary Streiker, visited one of these farms outside Ranthambhore National Park in mid-1997. The villagers were economically better off and appreciated having the bio-gas fuel, which saved them the effort of scouring the landscape for firewood, often a full-day's activity. This allowed them to devote time to crafts and other small businesses. Unfortunately, some of the other villagers around the park were still gathering wood, denuding the park. These age-old customs will be difficult to change. Eco-development and conservation projects in 60 villages surrounding Ranthambhore National Park have been launched. Conservation education on the importance of saving the forests will help to change attitudes and protect the park's wildlife and trees. This will bring tourists and new sources of income.

Preserving Forests: Page 6

Several remarkable successes have proved a positive contrast to the otherwise gloomy trends of forest destruction. In South America, large expanses of undisturbed tropical forest remain, but they are fast disappearing. The Amazon Basin and its forests once covered 2.3 million square miles, comprising three•fourths of the world's tropical forests, but forest clearing has destroyed some 20 percent of the original forests and damaged far more. Amazonian forests contain 14,000 endemic species of plants (Harcourt and Sayer 1996).

Parque Nacional Madidi, Bolivia's newest national park, covers 4.7 million acres, protecting a variety of threatened habitats and species. Avian diversity for this park is estimated at 1,088 species of birds, or 11 percent of the world's birds, the highest in any protected area in the world; among these are many threatened species and others with small ranges (Remsen and Parker 1995). This park, watered by numerous rivers, borders eastern Peru and includes a variety of threatened environments. Humid lowland forests, grasslands and montane cloud forests are among these. Resident birds include the threatened Yellow-rumped Antwren (*Terenura sharpei*) and various species of tinamous and curassows (Remsen and Parker 1995). The latter birds are among the first species to disappear from areas as a result of hunting and habitat destruction. A proposed hydroelectric dam, which would drown large sections of rich lowland forests., is a major threat to the park. It may have been stopped as a result of publicity by *National Geographic* magazine, which featured a cover story in 1999 on the importance of saving this park. Public opinion and the potential tourist trade may compensate this country for lost revenues from the dam. An even larger park of 8.6 million acres along the border with Paraguay, the Kaa-Iya del Gran Chaco National Park, protects the most sizeable block of endangered dry tropical forest in the world (Seve 1996). These two parks will preserve more than 20,000 square miles, and native tribespeople will play a role in administering them (Seve 1996).

Another positive development is the trend in a growing number of countries to share the profits from national park fees with local people and involve them in the decision-making processes of managing the park and the local wildlife. Madagascar has been successful at this, combining income from park fees with international grants to build schools, libraries and clinics for the local people. Patricia Wright, a primatologist, helped establish Ranomafana National Park to protect endangered lemurs as well as to protect the watershed from floods. In the recent past, deforestation carried out by local villagers had caused landslides that inundated their homes and caused water sources to dry up. They have become convinced of the importance of preserving the forests for their own survival. This new approach of educating local people on the benefits that would accrue to them as a result of conservation, as well as payment from park fees and profits from ecotourism, is the future of forest preservation.

Another trend that will prove important is the involvement of biologists studying wildlife with local people, learning from their observations and sharing the knowledge they uncover. Biologists in Madagascar who rediscovered an owl thought extinct, brought local students to see it and raised money for needed school supplies from birdwatchers who came from around the world to see the bird. This creates a positive impression on the local people and instills natural history curiosity and a realization of the uniqueness of their own wildlife. In the future, this may be expanded by showing them films about the natural world that surrounds them and opening up new worlds with books and publications about the subject. Very few people are aware of the endemic wildlife and plants in the environments in which they live, whether in the United States or the Cameroon. When people learn of the flora and fauna in their neighborhood that exists nowhere else, or is of biological importance, they are far more likely to protect it. Even in the United States, where Natural Heritage Programs chronicle the endemic and declining species of every state, the information has not always been made available to the public in the form of state publications or television or newspaper publicity that could have a major effect on whether forests and other habitats are protected.

A recent campaign to alert the public to the ecological advantages of choosing shade-grown, organic coffee has helped preserve rainforests in many parts of the world. A trend toward planting coffee plants in open fields rather than in the traditional way, as an understory to tall trees, has been devastating to tropical forests, home to both tropical birds and other animals, and to migratory birds from North America who spend the winter in Latin America and the Caribbean. Smithsonian biologists began this campaign in 1990 when they saw bird species decline with the planting of sun-grown coffee plants, and patented the logo "Bird Friendly" coffee. Such coffee is now commonly sold in health food and specialty stores and may become more popular as the public is educated about the problem. With the enormous popularity of coffee, this could make a major difference to birds and other wildlife.

North America™s Forests

The history of the destruction of all but 5 percent of the 850 million acres of old-growth forests in North America has been recounted in Chapter One. Second-growth forests now dominate the East, forests far different in species composition from the original virgin forests. The great chestnuts, elms and beeches are gone, and woodlands are now young, mixed pine and hardwood. Moreover, these forests are fragmented by roads and development. Only a few roadless areas remain. A few remnants of old-growth forests have been located in the East, primarily on steep slopes and areas that loggers found difficult to reach. In southern Maine, for example**,** a biologist recently located a stand of Black Gum trees, some 9 feet in circumference. One stump had 450 rings, and another, larger one was still thriving. It was estimated to be more than 500 years old, dating back to the time of Columbus. Unfortunately**,** this area is in the path of development (BG 2000). The Great Smoky Mountains National Park is a large block of forest totaling 500,000 acres in the southern Appalachians of eastern Tennessee and western North Carolina. This national park harbors some virgin old-growth and a wealth of rare native trees, plants and wildlife, including a great diversity of salamanders that inhabit its damp, mossy forest floors and fast-flowing streams. It sits atop a mountain range that is a meeting place of northern and southern species, an important area to the endangered Appalachian forest ecosystems and a primary migratory stopover and nesting area for threatened wood warblers and songbirds. This area recently has been designated an International Biosphere Preserve, and its diversity is being inventoried by a team of biologists and other earth scientists.

North America™s Forests: Page 1

Migratory songbirds of eastern forests have declined by at least 45 percent in the past 50 years. These dazzling migrants--wood warblers, vireos, tanagers, orioles, grosbeaks and thrushes--suffer from a variety of threats. Deforestation of tropical forests where many of these birds spend the winter has been a major factor. Species requiring mature, undisturbed forest have declined to the greatest degree, some losing up to 90 percent of their populations. Clearcut logging and fragmentation of their breeding forests by housing, malls, roads and other

development have consumed millions of acres, displacing these songbirds. Many birds returning from tropical wintering grounds find their breeding forests destroyed or too small for successful breeding. A small patch of woods large enough for only one male songbird, surrounded by agriculture or development, will be abandoned if the male is unable to hear the songs of neighboring males (Line 1995). Many birds establish territories and maintain them by singing and challenging other males.

Another effect of forest fragmentation has been the proliferation of forest edge species that prey on songbirds and their eggs (Terborgh 1992). The Brown•headed Cowbird (*Molothus ater*), a parasitic species, was once seen only in grasslands. In the past, when huge herds of American Bison roamed the prairies of the Midwest, cowbirds accompanied them, laying their eggs in the nests of grassland birds, who raised them as their own. With the disappearance of the Bison, cowbirds entered the forests bordering agricultural and pasture land, laying their eggs in songbird nests. Some cowbirds now remain close to domestic cattle and fly into the nearest woodland to lay their eggs. Their eggs usually outnumber those of the host species, and the large chicks instinctively nudge the small songbird nestlings out of the nest. Because of the increase in forest openings, the net result of these losses has been a 90 percent decline in the number of songbirds recorded in the 1940s in many eastern forests (Terborgh 1992).

A campaign to declare a large section of the forests in northern New England a reserve began in the mid-1990s. To add urgency to the need for a national park in Maine, New Hampshire and Vermont, a new species of thrush, native only to this region, has been discovered. Once considered a subspecies of the wide-ranging Gray-cheeked Thrush (*Catharus minimus*), Bicknell's Thrush (*Catharus aliciae*) was found to be a totally distinct species in 1995, smaller and with a unique song. A bird of high altitude forests, it has already disappeared from its only nesting area in Massachusetts, Mt. Greylock. The major breeding area for Bicknell's Thrushes is now Vermont, whose forests are under pressure from ski developments and proposed wind turbines. Additional populations of fewer than 3,000 birds inhabit neighboring southern Canada, but the traditional practice there of thinning forests renders these forests unsuitable. Its habitat of spruce-fir forests is dying out from acid rain and global warming (BI 2000). This threatened bird is also losing habitat in its West Indian wintering grounds, especially Hispaniola, where forests are being cleared (BI 2000).

Another member of the thrush family is declining toward extinction. Known for its melodious, fluted song, which many find more intricate and beautiful than the Nightingale's, the Wood Thrush (*Hylocichla mustelina*) has declined precipitously in recent years. Native to undisturbed hardwood and mixed forests in eastern North America, the Wood Thrush winters in Central America, from southern Mexico to southern Panama (Rappole *et al.* 1983). In August, these birds begin their southerly migration, often gathering in groups where the chorus of 50 or more Wood Thrushes may echo like a cantata in the tall trees. One research project studied these birds in one of their tropical wintering areas in the Tuxtla Mountain region of southern Veracruz, Mexico, on the Gulf of Mexico. Studies of this population of birds began in the mid-1970s when the wintering habitat consisted of primary rainforest. (Rappole *et al.* 1989). This forest has declined by 85 percent, a far higher percentage than elsewhere in Central America, leaving mere fragments of the once rich tropical rainforest (Rappole *et al.* 1989). In 1980, the two researchers returned to find that their 12-acre rainforest study plot had been converted to a patchwork of fields and forest fragments; less than 5 acres remained of the original forest (Terborgh 1989). Using radio•tracking and mist netting, researchers discovered that Wood Thrushes do not adapt to forests without tall trees, even as a wintering area, preferring undisturbed rainforest. Year after year the same individual birds returned to the same sites. In rainforest, they tended to survive the winter, while Wood Thrushes forced to winter in neighboring second-growth or disturbed forest had a high mortality rate from predators and other causes (Rappole *et al.* 1989).

Throughout their winter range, the forests that once harbored tens or perhaps hundreds of thousands of Wood Thrushes in Mexico and Central America have been turned to pastureland or tilled for agriculture. Between 50 and 70 percent have been destroyed (Collins 1990). Fewer and fewer Wood Thrushes return to nest in Eastern forests, even when they have not been fragmented or cleared (Terborgh 1989). Their nests have also been vulnerable to parasitism by Brown-headed Cowbirds (Terborgh 1989). In Illinois, for example, where Brown•headed Cowbird populations have skyrocketed in past decades, one study found that 29 of 30 Wood Thrush nests had been parasitized by

Brown-headed Cowbirds, who laid eggs that crowded out those laid by the thrushes; the conclusion of the study: "Wood Thrushes are doing nothing but raising cowbirds" (Terborgh 1989). In the few areas where forests are unbroken and extensive, Wood Thrushes have been successful breeders (Robinson 1996).

Unfortunately, the combined effects of habitat destruction in both its breeding and wintering grounds, and parasitism of its nests by cowbirds, may result in the extinction of the Wood Thrush. A recent study in several Midwestern states found that birds from large stretches of forest that are holding their own may be having young that disperse to neighboring forest fragments, only to be crowded out by cowbirds (Robinson 1996). The melodic Wood Thrushes are disappearing throughout their range, along with many other beautiful songbirds.*

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*See Video section. fiOn a Wing and a Song,fl a Canadian Broadcasting Co. film produced in 1994 for The Nature of Things series, explores the decline in songbirds. Another excellent film on the same subject with a similar title, fiOn a Wing and a Prayer,fl produced in 1995 by Kurtis Productions and WTTW for the PBS series New Explorers, concentrates on the decline in breeding songbirds of Illinois and their migrations.

Other changes in environments also contribute to songbirds' declines. Recent research has found that high levels of noise from highways, airports and other man-made activities have interfered with the ability of birds to sing breeding songs and breed successfully. Birds that migrate to the Caribbean and Latin America suffer high mortality from collisions with television and cellphone towers and tall buildings. For many years, one scientist at Chicago's Field Museum has collected migrating songbirds that died from flying into a single building near the museum**.** His collection now totals 20,000 birds. He estimates that total mortality from building collisions may be 60 million songbirds a year, an enormous loss.

A great concentration of breeding songbirds is found in Belt Woods, a 500-acre-forest near Bowie, Maryland. Trees that were growing when Columbus discovered America survive here. Perhaps the largest tract of old-growth forest in the region, it has a variety of habitats from swamp forest to dry hardwood stands. More than 40 species of migrant birds nest here, including Wood Thrushes, Rose-breasted Grosbeaks, Baltimore (Northern) Orioles, Scarlet Tanagers, Prairie Warblers and Ovenbirds. These are species that have disappeared from woodlands that have become fragmented, or contain few tall trees. This wealth of breeding birds underlines the importance of protecting old-growth forests. Privately owned, Belt Woods was willed by the late owner, William Seton Belts, to the Episcopal Church to be kept intact in perpetuity. The church, however, went to court in the 1990s to change the will to allow sale to developers, claiming that it had more important works to accomplish with the funds than saving the forest.

After conservationists had decided it was a hopeless cause, a local resident, Pam Cooper, decided to spearhead a rescue of these precious woodlands. By conducting publicity campaigns and fund-raising efforts, she and the Western Shore Conservancy raised money. A Maryland author and illustrator of children's books, Lynn Cherry, organized The Friends of the Woods to enlist children to help influence their parents and public opinion to place the preservation of this threatened woodland above that of sheer materialism and to champion the need to take on local conservation problems as a community. Her children's book, *Flute's Journey, the Life of a Wood Thrush*, chronicled the life of a Wood Thrush born in Belt Woods, its migration to Costa Rica and its uncertain future. The plight of Belt Woods was given national attention in April 1996 on a CBS program, "Sunday Morning," which may have been a crucial turning point in the preservation of this forest. Within months, an arrangement was finalized with conservation organizations that would turn Belt Woods into a reserve, ending the possibility that it would be sold to developers.

At a time when losses in the numbers of North America's beautiful songbirds may have become irreversible, scientific research is revealing that they play a crucial role in controlling insects in forests (Yoon 1994). In a controlled experiment, birds were excluded from a section of forest with netting cages that allowed insects to enter. It was found that trees and plants incurred twice the damage to foliage where birds were excluded (Yoon 1994). The

study concludes that songbirds constitute a major and important form of natural pest management, superior to pesticides (Yoon 1994). Keeping songbirds from nesting in a stand of White Oaks, other researchers found that caterpillars consumed so much foliage that the trees grew significantly more slowly than White Oaks with nesting songbirds (Robinson 1996).

North America™s Forests: Page 2

It would probably shock most residents of suburban New York City to know that 150 years ago, wild Gray Wolves preyed on White•tailed Deer, Eastern Bison and Elk in the dense virgin forests now occupied by their neatly clipped green lawns, while overhead the flight of millions of Passenger Pigeons darkened the sky. The Eastern United States is undergoing a "Europeanization" in which natural forest is being lost to housing tracts, highways and urbanization. This sprawl consumes the second-growth forests, some of which had become excellent wildlife habitat, and the new residents often contaminate the water and soil with pesticides and herbicides to maintain green lawns. The natural world and its fauna and flora are fast disappearing.

Just as they are disappearing, discoveries about the medical potential of eastern forest trees are being made. Recently a fungus was discovered that is a missing link in the life cycle of a mold that produces the billion-dollar drug cyclosporin, used to prevent the rejection of transplanted organs (Yoon 1996). The forest of the Finger Lakes Land Trust in Ithaca, New York, where Cornell University students found the fungus, has established the nation's first reserve set aside specifically for chemical prospecting outside the tropics (Yoon 1996).

Most of the Great Lakes region was originally covered in ancient pines. During the logging boom of the late 1800s, mills of one Great Lakes port alone, Ashland, Wisconsin, cut 500 million board feet of lumber a year (a board foot is equal to wood 1 foot square and 1 inch thick), enough for 50,000 houses (Johnson 1997). Timber barons shipped the lumber to rebuild Chicago after the great fire of 1871, and the logged-over area, covered in broken branches, stumps and discarded trees, ignited a series of fires, one of which killed 1,152 people in the town of Peshtigo, Wisconsin (Johnson 1997). These fires charred millions of acres, leaving a wasteland (Jonas 1993). By the end of the 19th century, the majority of these forests had been clearcut by commercial loggers (Jonas 1993). There remains a scarcity of timber, and in 1996 a treasure trove of 20,000 to 30,000 old-growth tree trunks was found by divers on the bottom of Lake Superior; they had sunk more than a century after being cut and floated to mills (Johnson 1997). Old-growth timber is extremely valuable. It has tight grain resulting from slow growth, unlike the grain in the trees grown on tree farms. These logs are worth many millions of dollars, and a company is bringing the logs to the surface, selling them for ten times the price of new wood (Johnson 1997). These are the last remnants of a once vast forest.

Early in the 20th century, Weyerhauser, the German timber magnate, having logged out the old growth of the Great Lakes area, turned to the forests of the Southeast. Forests dominated by Longleaf (*Pinus palustris*) and Shortleaf Pines (*Pinus echinata*), which have the world's greatest diversity of forest floor plants, dominated northern Florida west to Louisiana and north to central Georgia. Longleaf Pine forest once covered 90 million acres from Virginia to Texas. These forests also harbored Loblolly (*Pinus taeda*), Virginia (*Pinus virginiana*), Pond (*Pinus serotina*) and Pitch Pines (*Pinus rigida*), which grew in various types of soil and climatic conditions. Loggers decimated this ecosystem, cutting millions of board feet, and by the 1930s, these forests had been reduced to a fraction of their original extent. Today, only about 2 percent of the Longleaf Pine forests remain, making them the most endangered forest ecosystem in North America. For the most part, these forests have been replanted with other species, predominantly commercial tree farm monocultures.

Much of the remaining virgin pine forests of the Southeast lie on national forest land, and they are being heavily logged. On December 15, 1995, this destruction was fought by the Biodiversity Legal Foundation and the Alabama Wilderness Alliance, which filed suit in Federal District Court against the US Forest Service challenging the legality

of the Forest Service decision to open a series of massive salvage timber sales of trees blown down by a hurricane, along with some healthy standing trees, on 15,000 acres of the Conecuh National Forest in Alabama. The Biodiversity Legal Foundation hired biologists and other experts, who testified that Forest Service management of the forest violated its own environmental regulation relating to logging near waterways and had planted non-native trees instead of the native species that are preferred by the Red•cockaded Woodpecker (*Dendrocopus borealis*), an endangered resident of this forest. This lawsuit was settled in favor of the conservation organizations.

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A victim of this logging, the Red-cockaded Woodpecker is a small bird marked in black and white and named for the male's tiny streak of red on each side of the nape. These birds have very specific habitat needs. For nesting trees they usually choose old-growth pines stricken with red heart disease whose soft wood permits easy excavation of nesting holes; the sap running down the trunk deters snakes and other predators (McFarlane 1992). Red-cockaded Woodpeckers nest in small groups or clans, requiring large areas of undisturbed forest. Each clan has "helpers," non-breeding birds that aid in feeding the nestlings (McFarlane 1992). These woodpeckers were the primary control of the southern Pine Beetle, a major pest in pine forests; after destruction of old-growth pine forests, which endangered these birds, Pine Beetles proliferated and destroyed other types of pines (McFarlane 1992).

Prior to the commercial logging of the early 20th century, these woodpeckers may have numbered in the hundreds of thousands. Nineteenth century records exist of Red-cockaded Woodpeckers as far north as northern New Jersey and southeastern Pennsylvania, and west to Missouri (Jackson 1994). Gradually, their range shrank as pine forests were destroyed; by 1946 the species was gone from Missouri, and by 1976 from Maryland (Jackson 1994). Populations in Tennessee declined to a single bird by 1992, and they disappeared from northern Mississippi in 1977; Kentucky and Virginia have only a few family groups (Jackson 1994). In the Southeast, clans became rare and widely separated from one another as millions of acres of old-growth pine were logged. When listed on the Endangered Species Act in 1968, programs to prevent its extinction were launched. Inbreeding of Red-cockaded Woodpeckers is apparently occurring in populations isolated by forest fragmentation (Jackson 1994). Some females have been physically translocated to isolated groups without females to counteract this problem (Jackson 1994). Nest holes have been artificially created, and existing nest holes have been modified with steel plates, restricting the size of the opening to prevent predators and larger birds from entering the nest hole (Jackson 1994).

The problem of declining habitat remains, however, and some conservation organizations, including the Biodiversity Legal Foundation, have successfully taken the Forest Service to court concerning their replanting policies, obtaining court orders mandating replanting with Longleaf Pine to benefit the Red-cockaded Woodpecker. At present, only about 30 known clans remain, with South Carolina and Florida having the largest numbers; the entire population of the Red-cockaded Woodpecker may not exceed 7,400 birds (Collar *et al.* 1994).

One haven for the Red-cockaded Woodpecker is Eglin Air Force base, located on the Florida panhandle. This 460,000-acre base preserves the world's largest remnant of Longleaf Pine forest, which occupies 320,000 acres of the base (Stevens 1996); 10,000 acres of this forest are the largest remaining old-growth Longleaf Pine in the world, with many 400-year-old trees (Biondo 1997). The Nature Conservancy has spent years conducting biological surveys and has discovered that more than 90 rare or imperiled species, including a salamander new to science, inhabit the base (Biondo 1997). Eglin protects 1,200 plant species, with numerous threatened species among these. Military activities are carried out as carefully as possible, and the base employs a full-time chief of natural resources with a staff of 25 (Biondo 1997).

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The military conducts munitions tests on Eglin Air Force Base, causing fires that have inadvertently benefited the ecosystem. The piney woods of the Southeast need fire, without which shade-tolerant hardwoods begin to intrude on Longleaf and other native pine stands (Jonas 1993). At present, Eglin officials conduct controlled burns to maintain this habitat (Stevens 1996) and are removing non-native and overabundant plants and trees (Biondo 1997). To return the Longleaf Pines to former abundance, more than 3 million seedlings have been planted, restoring 200,000 acres over the past five years (Biondo 1997).

The Gulf Coastal Plain Ecosystem Partnership, a plan to link populations of Longleaf Pine forests, was formed in 1996 to protect 840,000 acres of contiguous forest held by seven major landowners in northern Florida and southern Alabama (Biondo 1997). The partnership has signed a memorandum of understanding that encourages cooperation between the diverse owners, from private logging companies to state forest departments and water management districts (Biondo 1997). More than 160 rare or imperiled plants and animals reside in these lands, and Eglin Air Force Base's land has been the best preserved of any because of limited human intrusion and very little logging. It also protects a sizeable population of threatened Gopher Tortoises (*Gopherus polyphemus*). This keystone reptile excavates deep tunnels and cavities which provide habitat and shelter during fires for hundreds of animals, including threatened species.

Southern Bald Cypress (*Taxodium distichum*) swamp forests were once found in many low-lying areas of the South, but today, the Okefenokee Swamp is the largest remaining tract. Plans to clearcut this huge forest were abandoned early in the century after logging proved unprofitable. Later, the Okefenokee was declared a National Wildlife Refuge, and it is one of the most important examples of this ecosystem, home to River Otters (*Lutra canadensis*), Alligators (*Alligator mississippiensis*) and abundant water birds.

Massive stands of ancient Live Oaks (*Quercus virginianus*) draped in Spanish moss evoke the very essence of the South. Although the majority of these huge trees have been logged, many survive that are 10 to 12 feet in diameter. They have a dense wood that was used in the construction of ships such as the USS Constitution. This ship was called "Old Ironsides" because this hardwood was impervious to cannonballs. The last sizeable stands of these picturesque trees are disappearing, however. Companies are buying wood lots with Live Oaks, cutting and replacing them with tree farms of fast-growing pine. As an added threat, a fungus first identified in the 1940s as "oak wilt," has been killing many Live Oaks. The disease chokes the flow of water into the tree and gradually kills it from the inside out, spreading through root connections which link Live Oaks growing in close proximity. In Texas, where this disease has killed many of these oaks, the Texas Forest Service has been successful in injecting chemicals that kill the fungus and digging trenches that break connections between these oaks.

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Predators of the Southeastern forests declined or disappeared after European settlement as a result of overhunting and persecution, leaving an imbalance in which White-tailed Deer proliferated without Grey Wolves or Mountain Lions to limit their numbers. Both the latter predators remain absent in the eastern United States, although there are unsubstantiated sightings of Mountain Lions in Maine and elsewhere. A few Grey Wolves have entered northern Maine in recent years, and some conservation organizations have proposed reintroductions of the species into Adirondack Park in New York state or in northern New England. Red Wolves (*Canis rufus*) were totally eliminated by predator control programs and hybridization with the Coyote, reaching extinction in the wild by 1973 when the last

wild members of the species were taken into captivity. This uniquely American species, which until recently was considered to have been native to only the southeastern United States, is now thought to have been distributed throughout eastern North America, based on DNA testing showing close relationships between the Red Wolf and wolves of eastern Canada, which have managed to persist to the present. The species was larger in northern states and preyed on deer and elk. Red Wolves survive today as a result of the 14 animals that formed the nucleus of the Fish and Wildlife Service's breeding colony. By 1993, more than 233 animals resided in 31 breeding facilities. Several successful releases have taken place in North Carolina and other eastern states, and about 100 Red Wolves survive from these releases.

West of the Mississippi River, pine forests in the mountainous regions of the Southwest were also heavily logged. A resident of these forests, the southern Mexican Spotted Owl (*Strix occidentalis lucida*), a race of the Spotted Owl, whose northern race inhabits old-growth forests of the Pacific Northwest, has become very rare. This owl, like its northern relative, requires undisturbed forests. The dominant tree of the southwestern forests is the Ponderosa Pine (*Pinus ponderosa*), which towers 180 feet tall and can live 500 years (Jonas 1993). Originally, these trees covered hundreds of thousands of acres in northern Arizona, New Mexico, and neighboring states; old-growth pine forests also stretched south into northern Mexico. Beautifully adapted to the dry, mountainous habitat, Ponderosa Pines often grow in large, pure stands. These forests have very little old growth left today, and Mexican Spotted Owls have disappeared from national forests in Arizona and New Mexico after the oldest trees were logged (Johnson 1995).

Many unusual and endemic species live in pine and juniper forests of the Kaibab Plateau on the north rim of the Grand Canyon. The Kaibab Squirrel (*Sciurus aberti kaibabensis*) is confined to this plateau. This beautiful squirrel is considered by most authorities to be a subspecies of Abert's or Tassel-eared Squirrel, but some zoologists treat it as a separate species. One of the most dramatic looking of all squirrels, the Kaibab is dark brown, with long tassels on its ears, and a snow-white bushy tail. Its close relative, Abert's Squirrel, is dark, grizzled gray on its back and tail. Feeding mainly on conifer seeds, these squirrels suffer high mortality from hunting, road kills and natural predation by hawks (Whitaker 1980). Their habitat is restricted, and they are considered a rare and endemic animal. Ecologically, these squirrels are important in helping the Ponderosa Pine reproduce. They dig for truffles and absorb their spores, which enter their feces. When their feces are deposited near Ponderosa Pines, they spread the spores to the tree's roots, which grow into a fungus, triggering the tree's reproductive biology. In the spring of 2000, wildfires raged through their habitat, undoubtedly causing the squirrels high mortality.

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The problem of illegal logging is growing in the national forests, and a recent threat is the invasion of forests by drug growers. These people have entered roadless federal lands in the West and are seldom detected because of the remoteness and size of many of these tracts. In Los Padres National Forest, they destroyed large sections of forest in 1995 and 1996 to plant marijuana. After cutting trees, they cleared brush with herbicides which killed native plants, many of which are rare and protected. They also diverted scarce water from streams to irrigate their plants, which eliminated native plants dependent on that water. The drug growers put out poison to kill animals, such as deer, they feared might eat the marijuana. This situation presents a major threat to many species of wildlife, and especially to California Condors, who have been reintroduced to Los Padres National Forest and feed on carrion.

Ancient old-growth pine forests covered much of northern Mexico until a few decades ago. Large-scale logging has been felling these great trees, and what reserves have been set aside to protect the remaining patches of old growth are not carefully patrolled to guard against illegal logging. The Imperial Woodpecker (*Campephilus imperialis*), the world's largest woodpecker and one of the most beautiful, declined to extinction as a result of failure by both the Mexican government and private conservation organizations to preserve its habitat. Its decline began from hunting, and logging removed its feeding and nesting habitat during the first half of the 20th century. Several of these birds

were sighted in the 1990s, but because no emergency action took place to preserve these birds in their last retreat, they disappeared. Each pair of Imperial Woodpeckers required a habitat of at least 25 square kilometers, and no area of old-growth forest this large now remains in the Sierra Madre Occidental (Lammertink 1996). Only a few fragments of old growth survive in this huge area, and even these are in imminent danger of being logged.

Mexican logging companies offered local people $2,000 per household for permission to log, and this may have been the deciding factor that led to the end of Mexico's old-growth forests. All that remains of the Imperial Woodpecker are museum specimens. A photograph of three specimens was recently published in the article, "The Lost Empire of the Imperial Woodpecker," in *World Birdwatch* (Lammertink 1996). Martjan Lammertink concluded after his field survey that if the Imperial Woodpecker still exists, no breeding habitat remains and, at most, one or two solitary birds may be left who must fly over huge areas to find food (Lammertink 1996).

A courageous defender of the Sierra Madre forests, Mexican activist Edwin Bustillos has risked his life to fight the drug lords who have taken over large areas in these forests for cultivation of drug plants. In several incidents, Bustillos had five ribs and his arm broken and spent a month in the hospital from injuries sustained when attacked by drug dealers. In 1996, he received the Goldman Environmental Award for his long-term efforts on behalf of these endangered forests.

A beautiful parrot also inhabits these same pine forests. The Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*) once flew in large flocks in search of pine seeds, but its populations have declined from loss of old-growth forests and illegal shooting. The species is listed on the US Endangered Species Act, as endangered by the *2000 IUCN Red List Species*, and on CITES Appendix I, which bans all commercial trade. These large green parrots have red feathers on their foreheads, shoulders and thighs, and bare skin surrounding their yellow eyes. Their large hooked beaks aid them in prying open pine cones. Native to Sierra Madre Occidental of eastern Mexico and, originally, pine forests in Arizona, Thick-billed Parrots live mainly above 2,000 meters. Heavy logging of old-growth pine forests has destroyed 99 percent of its habitat and removed the huge, old trees it needed for nesting (BI 2000, Collar *et al.* 1994). A field survey in 1994 in southern Chihuahua uncovered massive forest destruction and the penetration into its habitat of drug-growers, cattle and loggers (Collar *et al.* 1994). Populations have declined from flocks of thousands seen in the 1950s (Lammertink 1996) to about 5,000 in 1992 and only 1,000 to 4,000 in 1995 (BI 2000). Reintroductions into Arizona of captive-bred birds have not been successful because the birds did not know how to avoid predators or forage for pine seeds (BI 2000).

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Some highly threatened birds persist in unlogged portions of northern Mexico. The beautiful, iridescent Eared Quetzal (*Euptilotis neoxenus*), for example, was formerly common but is now confined to corridors of unlogged trees along rivers. These bits of forest are, at the present at least, inaccessible to loggers (Lammertink 1996). These quetzals require large trees for nesting and lay their eggs in cavities created when large tree snags fall off. Such trees, however, are rare and may disappear altogether in the future, since loggers cut them down as a general rule. It is considered Near-threatened, and close to qualifying as Vulnerable by BirdLife International (BI 2000). The Tufted Jay (*Cyanocorax dickeyi*) is another striking bird with a stiff, bristly, black fan crest on his head and forehead, unlike any other jay. This species is endemic to a limited area in the southern Sierra Madre Occidental, in mixed forested hillsides of oak, dense evergreen and deciduous forest near watercourses. Although a Near-threatened species (BI 2000), it has, nevertheless, no protected reserve.

Pine forests extend south to central Mexico, and up to 30 million Monarch Butterflies (*Danaus plexippus*) from the eastern United States and Canada migrate up to 2,000 miles to several groves of fir trees where they spend the winter clinging to branches in a semi-torpor. These butterflies constitute 90 percent of the species' population, and scientists

believe that they have wintered here for more than 10,000 years (Aridjis and Brower 1996). Their migration is a biological mystery and unique among butterflies. Until the fir groves, where they festoon the tall trees like dazzling orange and black ornaments, were discovered, no one knew where they spent the winter. Even now, their method of locating this particular forest remains unknown. The butterflies that fly south are third generation ancestors of the ones who wintered in Mexico the previous year. On warm days, they wake from their torpor and venture out to take nectar, and in the spring, they head north, breeding along the way (Pyle 1981).

Entirely dependent on these groves of firs, which shelter them from the freezing rains that fall in this high-altitude forest, the Monarchs are threatened by logging. In spite of a 1986 order by Mexican President Miguel de la Madrid to protect the five wintering populations, all located in close proximity, the surrounding trees were not given protection. Local people cut trees for fuel and building materials, and cattle trample fir seedlings (Aridjis and Brower 1996). They have logged up to the very limits of the groves, and without the protection of bordering trees, the butterflies are more vulnerable to cold spells, dying in unprecedented numbers. Snowstorms and cold weather killed millions of these fragile butterflies in 1991 and 1995.

Ann Swengel and Dr. Paul Opler, who coordinate nationwide butterfly counts for the Xerces Society, a butterfly conservation organization, began noticing declines in Monarch populations in the United States, and scientists have seen many declines in areas where they were previously abundant.
Conservation of the precious fir trees upon which the species winters is a key to saving this species. Dr. Lincoln P. Brower, professor of zoology at the University of Florida and a leading authority on the species, and Homero Aridjis, President of the Group of 100, a Mexican environmental organization, made a public appeal for the protection of the Monarchs' winter habitat in an Op-ed article for *The New York Times* in January 1996 (Aridjis and Brower 1996). They maintained that all three countries--the United States, Canada and Mexico--should cooperate to purchase the forests in keeping with the North American Free Trade Agreement (NAFTA) (Aridjis and Brower 1996). A comparison of forest cover in the Monarch groves based on aerial photographs taken in 2000 and in the 1950s, shows great losses in these protected trees from illegal logging over the past 40 years. The situation has reached crisis proportions, according to scientists. In response, the Mexican government has promised to protect the remaining groves and enlarge the reserve. Local people have expressed opposition, however, as they have traditionally logged the forests and have not profited from the tourists who come to see the butterflies. If this situation is not resolved in favor of the butterflies, these beautiful jewels that brighten fields and gardens may disappear from their breeding grounds in the United States.

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The ancient forests of the West Coast once stretched from northern California nearly unbroken through coastal Canada to southeastern Alaska, covering 70,000 square miles. Logging by Europeans began in the 19th century, and as the forests fell, a few voices were raised in protest. Even Horace Greeley, a promoter of "progress" and settlement of the West, exhorted Americans in 1851 to "spare, preserve and cherish some portion of your primitive forest" (Peck 1990). It was the fiery Scottish wilderness advocate John Muir who finally succeeded in convincing the US government to protect some of these ancient forests. He settled near California's Yosemite wilderness in the 1860s and began passionately denouncing the destroyers of nature, from loggers to livestock operators. Muir pointed to the political influences that allowed destruction to occur. During the 19th century, livestock swarmed in great numbers over wilderness areas. Muir described sheep as "hoofed locusts" and, in trying to get them removed from Yosemite, said, "As sheep advance, flowers, vegetation, grass, soil, plenty, and poetry vanish" (Peck 1990). When he saw the ancient Sequoias being cut, Muir was outraged:

Through all the wonderful, eventful centuries since Christ's time--and long before that--God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but He cannot save them from fools--only Uncle Sam can do that.

Muir proved to be an adept politician, making friends with influential magazine editors and railroad magnates; President Theodore Roosevelt camped out with Muir in Yosemite in 1903 (Peck 1990). Through Muir™s influence, Yosemite became a national park in 1906, followed by Sequoia, Mt. Rainier, Crater Lake, Glacier and Mesa Verde National Parks (Peck 1990). In 1892, Muir established The Sierra Club conservation organization. If not for Muir's courageous and effective work on behalf of these forests, it is likely that very little old-growth forest land would remain today.

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These centuries-old trees, often covered in epiphytes, plants that get nutrients from moisture and air, and lichens, including one species that drapes over branches in delicate, lacy strands, exude a lushness reminiscent of tropical rainforests. More than 140 inches of rain per year produce luxuriant tree growth and a verdant understory of ferns and hardwoods. Bright green mosses and masses of ferns carpet the ground, and a great variety of mushrooms and lichens flourish in the damp environment. In the spring, the forest floor is carpeted with beautiful white trilliums and other flowers that contrast with the deep greens of the forest. Mist and fog enshroud the giant trees, which intercept the moisture from the atmosphere, supplying the trees and the entire environment with water throughout the year (Ellis and Kane 1991).* The southern portion of these forests is dominated by Coast Redwoods, with the record tree reaching more than 365 feet in height. Its upper branches are more than 50 feet in length. They are among the most ancient as well, some over 2,000 years old (Middleton 1992). The great Redwoods of northern California gradually melt into a forest of mixed pines, fir, cedars and hemlock.

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*Along with the fine book by D. Middleton (1992), cited frequently here, *North America's Rain Forest. The Endangered Paradise*, by Gerry Ellis and Karen Kane (NorthWord Press, 1991), is an excellent resource, beautifully illustrated with the trees, plants and wildlife of these forests, and shows the devastating clearcuts contrasted with living forests. *Western Forests*, a book in the *National Audubon Society Nature Guides* series illustrates most wildlife and plant species, as well as discussing forest ecosystems.

Douglas Firs (*Pseudotsuga menziesii*) grow to ages of 700 to 1,000 years old in climax growth, veterans of hundreds of periodic fires; they may reach 325 feet in height (Jonas 1993). A tree 250 years old is considered young in an old-growth forest, while middle age is 400•500 years, and old age is more than 700 years (Middleton 1992). Recent research conducted in these forests indicates that rich diversity does not develop until forests are at least 200 years old (Moffet 1997).

Ancient Red Cedars (*Thuja plicata*) grew in abundance in these old-growth forests and were among the first to be cut by loggers. Old specimens are very rare at present, and activists recently saved one area with many exceptionally old and massive cedars from being logged. This forest, in Upper Priest Lake, northern Idaho, has cedars 1,500 years old. The largest trees are 20 stories tall, with trunks 10 feet in diameter. The ground beneath is carpeted with ferns, including the largest population of Braun's Holly Fern in the West. Old-growth cottonwoods also grow here. Endangered Woodland Caribou (*Rangifer tarandus caribou*), threatened Grizzly Bears, Fishers and Wolverines, rare Cutthroat Trout, endemic salamanders, and Harlequin Ducks are resident in the forest and wetlands. This forest covers 520 acres, worth at least $9 million to the lumber company that owns it. The US Forest Service was unable to

obtain federal money to purchase it in 1996, and not until October 1997 was the grove preserved through a trade of land worth $8.7 million between the owner and the Forest Service.

More than 1,000 plant and animal species depend on old-growth forests (Egan 1994a). Invertebrate animals of the soil are highly diverse: an area 1 meter by 1 meter shelters 200,000 mites of 75 species (Middleton 1992). Fallen logs may take 500 years to rot, and this decaying wood is fed upon by the most diverse fungal network in the world (Middleton 1992). The hollow logs are used as nest holes by Red•backed Voles and other small species. The young of these voles feed on truffles that grow in the rich soil. At least 300 insect species have been described from the rotting•log community of organisms (Middleton 1992). A host of other insect species of the forest canopy have yet to be described.

Many vertebrates depend on the old-growth forests of the Pacific Northwest for their survival, and some of these live nowhere else. The Sitka Black•tailed Deer and Roosevelt Elk and a unique bluish strain of American Black Bear from southeastern Alaska are among these. Bats of several species--Long•eared, Hoary and Silver•haired--are major pollinators and insect-predators in forests of the Pacific Northwest. Roosting in the hollow trunks of ancient trees, these bats have declined in many areas because of logging. A great diversity of amphibians lives in the moist environments of these temperate rainforests. Among them are the Slender, Olympic, Pacific Giant and Del Norte Salamanders, Pacific Tree Frog and Tailed Frog.

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The Northern Spotted Owl (*Strix occidentalis caurina*) may be the most famous resident of these forests. The struggle over old-growth forests became a bitter controversy focused on the fate of this bird, which was declared a Threatened species under the Endangered Species Act in June 1990. This owl is native to old-growth forests in northern California, Oregon and Washington, and each pair of owls requires up to 3,200 acres as territory, making it a naturally rare species (Middleton 1992). Northern Spotted Owls nest in natural tree cavities or holes created when great branches from living trees fall to the ground. The canopy above shields owlet chicks from the view of large birds of prey that fly above. These owls feed on the Red Voles, Dusky-footed Wood Rats and Northern Flying Squirrels that are abundant in old-growth forests. When these forests are cut and young second-growth forest takes over, Spotted Owls disappear (Seideman 1997). In spite of the protection of portions of their habitat, these owls have not recovered their numbers since listing on the US Endangered Species Act, and they continue to decline. The US Forest Service released extensive data compiled on the populations of these birds between 1985 and 1993, which showed a drop of 4.5 percent a year, with an accelerating rate of decline (Seideman 1997). Another threat to these owls is the recent invasion of their habitat by the larger and more adaptable Barred Owl, which is displacing the Spotted Owl in some areas. Even more ominously, interbreeding has taken place between the two species (Seideman 1997).

When the Northern Spotted Owl was listed as Threatened on the Endangered Species Act and large sections of its habitat protected, it became a focal point, polarizing pro-logging and anti-logging advocates. Owl haters urged others to kill these birds, who were blamed for ending the logging industry. Their cars sported bumper stickers such as "Kill an Owl, Save a Job." Such venom totally obscured the fact that the forests were being overcut and that logging jobs were destined to be eliminated anyway, as the last old-growth forests disappeared under the saw. A state in the heart of this owl's range, Oregon, found that reducing logging ended up helping its economy; an influx of technology businesses provided better salaries than those paid for logging jobs (Egan 1994b, Verhovek 2000). The Governor of the state supported the logging restrictions as helping to maintain the overall quality of life in the state, preventing

floods and attracting tourists, which are supplying another large segment of the state's revenues.

Habitat Conservation Plans (HCPs), authorized under the Endangered Species Act may be contributing to the Spotted Owl's decline. Under these plans, agreements are negotiated with landowners which include a provision known as "no surprises." This gives landowners assurances that once the regulations on their properties have been agreed to, they are exempt from further restrictions. Should new populations of an endangered species be discovered on their property, they have no obligation to protect them. Habitats of Spotted Owls in old-growth forests in Washington State have been bartered away in HCPs that, in the view of Eric Hanson, biologist for the Yakima Indian Nation in Washington state, will end in reducing the state's populations of this species by 35 percent, from 880 breeding pairs to 550 (Seideman 1997). These HCPs allow habitat destruction and other actions that can result in deaths of Spotted Owls. The Forest Service collected population data on these owls for the years between 1994 and 1996 but failed to issue the results (Seideman 1997).

The Clinton Administration sponsored a series of local meetings to resolve differences. These resulted in plans to federally fund job•training for loggers who might become unemployed by logging cutbacks. Even so, logging interests sued the federal government to nullify the stricter quotas, and the California Forest Products Association unsuccessfully petitioned the Fish and Wildlife Service in October 1993 to remove the Northern Spotted Owl from the Endangered Species Act, claiming the species was mistakenly placed on the list. This case was argued all the way to the US Supreme Court which, in the summer of 1995, made a historic decision upholding the Endangered Species Act and its protection of endangered species' habitats.

The Timber Salvage Act of 1995 made a mockery of previous attempts to mediate between loggers and conservationists, allowing a year and a half of totally unregulated logging in the habitat of the Northern Spotted Owl and other threatened species. This law had the stated purpose of taking only fallen and dead trees, but in practice, tens of thousands of old-growth, healthy trees were logged. In its quarterly report on the Timber Salvage Act, issued February 29, 1996, the Forest Service reported that an astounding 2.1 *billion* board feet had been cut since passage of the law. The Forest Service's stated objective was to sell 4.5 billion board feet by the end of 1996. By August 1996, some 2.9 billion board feet, the equivalent of 580,000 logging trucks full, had been cut under the Timber Salvage Act (Bass 1996). National forest lands to be logged totaled at least 50 million acres. Major habitat areas for many endangered and threatened species were among these lands. Fortunately, this law expired at the end of 1996.

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The Marbled Murrelet (*Brachyramphus marmoratus*) is also dependent on old-growth forests and has been seriously impacted by the logging that, since the 19th century, has destroyed 95 percent of its old-growth habitat in the US Pacific Northwest. This small, black-and-white seabird is a Threatened species on the US Endangered Species Act and is listed as Vulnerable by BirdLife International. Unlike any other seabird, this Murrelet nests high in the branches of 200- and 300•foot trees. Sometimes seen in offshore waters of the Pacific Northwest and Alaska, their nests are rarely found. In fact, only about 30 nests have ever been located in the Pacific Northwest--all high in the

crowns of old-growth forest trees.

A researcher who was studying the ecology of old-growth tree canopies made an exciting discovery of a Marbled Murrelet nest. He photographed the adult on its nest, made of lichens, with a small fish in its mouth for its chick for *National Geographic* magazine (Moffett 1997). Despite surveys up and down the Pacific coast, this was one of the few nests found in 1996, and plans for logging near the nest site were stopped (Moffett 1997). A prime area for Marbled Murrelets is the Olympic National Forest in Washington state where large tracts were sold for clearcutting in 1996 under the Timber Salvage Act. In Umpqua National Forest, Oregon, over the weekend of March 23-24, 1996, several thousand-year-old Douglas Firs were cut; their age was determined by coring and ring counts. The Umpqua River has endangered populations of Coho Salmon (*Oncorhynchus kisutch*) and sea-run Cutthroat Trout, and logging may eliminate them. The Marbled Murrelet's nesting trees are being logged throughout the species' range. A few areas have been protected in Alaska, but they are declining rapidly, at a rate of 31 to 48 percent per decade, with little hope that sizeable areas of old-growth forest will be protected (BI 2000).

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The Pacific Yew (*Taxus brevifolia*)**,** found only in these forests of the Pacific Northwest, is considered a "trash species" by foresters who clear it away to make room for more valuable species. This plant grows in the undergrowth of old-growth forests from California to southeastern Alaska (Jonas 1993). It has recently been shown to contain a chemical substance, Taxol, that has proven effective in treating ovarian and other cancers (Middleton 1992). A rush to cut these trees and strip their bark to obtain Taxol threatened them with extinction until the chemical was successfully produced synthetically. Taxol will be a major new tool in treating cancers and will result in sales totaling many millions of dollars for the pharmaceutical industry.

These discoveries have taken place as the fate of the last stands of old-growth forests is hanging in the balance. Ninety-five percent of these forests in the United States, and more than 60 percent in Canada, have already been cut. Opposition to clearcutting is increasing, however. Lewis H. Nash is a member of an organization known as the "Environmental Air Force," which chronicles illegal cutting of Coastal Redwoods. Members pilot small planes over clearcuts and document the damage with photographs. Nash's work enabled an environmental lawyer to obtain an injunction in 1995 stopping logging the same day (Goldberg 1996a). In 1996, flying over the devastated forests of northern California, Nash remarked: "When I first started flying here 10 or 15 years ago, this was all the same, all primeval forest. All this has been pretty well hacked over" (Goldberg 1996a).

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One of the most heated debates over these forests involves the last privately-owned large tracts of redwoods. Commercial exploitation began in 1900 when Frederick Weyerhauser purchased 900,000 acres for $6.00 per acre, a ludicrously low price even in those days (Dietrich 1992). Almost all privately owned old-growth forests became depleted by the 1960s. One exception was a large tract of old-growth Coastal Redwoods and Douglas Firs in California's Humboldt County, in the northern part of the state, owned by the Pacific Lumber Company. This family-operated company had left most of its 200,000 acres intact and had been particularly protective of the most ancient trees in the 55,000-acre Headwaters Forest. In 1986, however, Houston financier Charles Hurwitz took over Pacific Lumber, using junk bonds. Hurwitz's United Savings Association of Texas failed, costing US taxpayers $1.6 billion, part of the savings-and-loan collapse (Brown and Stark 1995).

To pay his debts, Hurwitz began clearcutting the old-growth Coast Redwood and Douglas Firs. By 1995, he had

cut 40,000 acres of the Headwaters Forest and nearby old-growth trees, leaving only 5,500 acres of virgin Coastal Redwood and 5,000 acres of virgin Douglas Fir (Brown and Stark 1995). This is one of the most extreme cases of abuse of private land in the history of this country. Two-thousand-year-old trees were turned into picnic tables, lawn furniture and patio decks. Logging was delayed by several lawsuits, and to protect nesting sites of Marbled Murrelets, the California Forestry Department recommended in 1995 that Hurwitz be refused permission to build a logging road into the 4,400-acre grove of the most ancient trees (Brown and Stark 1995). Two California Congressmen, George Brown and Pete Stark, proposed that the federal government engage in a debt-for-nature swap, in which the Federal Deposit Insurance Corporation, which has sued Hurwitz for his role in the failure of his bank, would, through a special arrangement set up by the President, exchange the redwoods for his debt (Brown and Stark 1995). Hurwitz rejected the idea, calling it a "so-called fantasy of debt for nature" and threatened lawsuits against the government for excessively limiting the use of his land (Goldberg 1996b).

The value of the Headwaters Grove is estimated at between $100 and $500 million, with many giant trees several thousand years old and 12 feet in diameter; individual trees are worth more than $100,000 each (Goldberg 1996b). The ecological and esthetic values, however, are inestimable. Hurwitz called environmentalists who blocked sale of these trees "extremists" and insisted that he expected to be paid "fair market value for these trees" (Goldberg 1996b). Acrimonious negotiations for the grove continued in 1996 and 1997, with environmentalists demonstrating against an agreement negotiated that would protect only 7,500 acres, instead of the 100,000 they wanted saved. Early in 1997, Hurwitz demanded that he be paid in cash rather than land that was offered by the state of California, land which many environmentalists thought should be protected (Golden 1997). The deal arranged with Hurwitz allowed extensive cutting of the remaining 100,000 acres of old-growth forest without regard for endangered species' habitat.

Members of Earth First! began protests, entering the land and attempting to block logging trucks, and a young conservationist, Julia Hill, who became known as Julia "Butterfly" Hill, climbed up near the top of an ancient redwood tree she called Luna and refused to come down. She stayed up in this tree for two entire years, until the spring of 2000, while trees were cut in the surrounding area, until a sum of $50,000 was paid to the Hurwitz lumber company for Luna and 2.9 acres of surrounding forest, which were donated to Humboldt State University. She came down from the tree at last, a symbol of the extreme devotion and zeal that have been expended in attempts to preserve these ancient trees. The forest will continue to be cut, however, which will be a permanent loss to the environment and a stain on state and federal governments for not taking a stronger role to preserve the entire forest.

In a sad footnote, in November 2000, a vandal sawed a cut 32 inches deep and stretching 19 feet, or half the circumference, across the base of Julia Hill's tree, Luna. It appeared to have been done by a professional logger, judging from the precision of the cut. A team of specialists--an arborist, an engineer and a forester--was convened to try to save the tree (Quinn 2000). Metal braces were drilled into the tree spanning the cut. All efforts are being made to save this ancient tree from falling in winter storms. Visitors are being asked to stay away because the soil and hillside are being deeply eroded. It is a symbol of the senseless destruction of ancient forests.

Only 4 percent of the once vast and magnificent Coastal Redwood forests remain. These trees covered at least 2 million acres prior to logging, but only about 84,000 acres of virgin redwoods have been protected in state parks and the Redwood National Park; another 66,000 acres of logged and second-growth redwoods have been set aside (DiSilvestro 1990).

North America™s Forests: Page 14

Another major conservation struggle involves the magnificent Tongass National Forest in southeastern Alaska. This forest, covering 17 million acres, is the country's largest national forest--a mosaic of glaciers, mountains, fjords and islands covered by ancient trees. It makes up half of one of the largest remaining temperate rainforests on Earth,

which extends 1,000 miles in an arc along the southeastern coast. At least 6 million acres of Tongass are--or were--old-growth rainforest (DiSilvestro 1990). Sitka Spruce, Western Hemlock, and Red and Yellow Cedar many hundreds of years old dominate the forest.

The Tongass is home to a number of rare animals. Approximately 10,000 Bald Eagles nest in the tops of trees (DiSilvestro 1990). More Grizzly Bears live in the Tongass than in the entire lower 48 states, denning in the holes of towering old trees. A race of the Grey Wolf known as the Alexander Archipelago Wolf (*Canis lupus ligoni*) inhabits the Tongass; numbering only about 1,000 animals, its population is in decline (Williams 1995). Logging threatens these wolves and rare wildlife, including the Queen Charlotte Goshawk (*Accipiter gentilis laingi*) and the Marbled Murrelet (FWS 1994). The Wolf and the Goshawk are candidates for listing on the Endangered Species Act. These and other species of this beautiful area cannot survive in clearcuts and logged-over forests. The American Rivers organization has listed Tongass's Thorne River as one of the 10 most endangered in the United States, having become silted and its banks eroded from logging (Williams 1995).

The cutting of the Tongass's giant trees began in 1833, and by 1926, six sawmills were operating; by 1930, most of the lowland and easily accessible timber and giant old trees had been cut (DiSilvestro 1990). In the 1950s the Forest Service allowed cutting of ancient trees in rugged, steep areas and opened the way for a wood pulp industry to be fed by clearcutting. The Service offered two 50-year contracts at bargain-basement prices, instead of the usual three- to five-year contracts (DiSilvestro 1990). It signed an exclusive contract with the Ketchikan Pulp Corporation and, unlike other national forests where contracts are open to bidding, this contract was awarded during secret meetings from which the public and conservation organizations were excluded. From this time onward, 200 million board feet or more of old-growth forest were logged annually from the Tongass National Forest (DiSilvestro 1990).

The Alaska National Interest Lands Conservation Act of 1980 divided most of the state among federal, state and native interests. Within the law was a provision requiring maximum logging levels in the Tongass National Forest, with the quota of 4.5 *billion* board feet to be logged every decade, with annual subsidies of $40 million from the federal government for logging roads and other aid to timber companies (DiSilvestro 1990). In the 15 years that followed, billions of board feet were logged in this magnificent rainforest, at a financial loss to the taxpayer.

National organizations, including the Taxpayers for Common Sense based in Washington, DC, criticized the clearcutting of this and other national forests which provide no income to the federal treasury and are entirely subsidized by public funds (Schmitz 1996). A 1995 General Accounting Office report found that Tongass's Timber Program was the biggest money loser in the National Forest system, with a negative net return of $102 million to the US Treasury between 1990 and 1994 (Schmitz 1996). More recently, a study by the John Muir Project found that in the years 1997 through 1999, the National Forest Service Timber Sale Program operated at a net loss to taxpayers of more than $3.3 billion (Hanson 2000). This research found that less than 3 percent of the country's total annual wood consumption, and less than 4 percent of the sawtimber used for construction, comes from national forests (Hanson 2000). A nationwide poll in 1998 found that 69 percent of Americans oppose allowing timber companies to log the national forests (Hanson 2000).

The fight to save these forests is being waged in the courts, with public criticism and legal actions brought by conservation organizations. A 1987 book, *The Tongass. Alaska's Vanishing Rainforest*, dramatically illustrated the great beauty of this forest and the ravaging effects of logging, including clearcuts on steep, erodable slopes. This publication served as a catalyst for the passage of the Tongass Timber Reform Act of 1990 that stopped the $40 million subsidy to loggers and set aside 1 million acres to be closed to logging (Ketchum and Ketchum 1994). It did not stop or appreciably slow logging elsewhere in Tongass, however, and called for 150 million board feet a year to be cut. The book was updated in 1994 and described the continuing bitter battle being waged to protect this vast area (Ketchum and Ketchum 1994). In 1997, the heavily polluting Ketchikan pulp mill was finally closed. The Forest Service's 10-year plan for Tongass National Forest, finalized in May 1997, opened up 670,000 acres to logging, authorizing the cutting of 220 million to 267 million board feet of timber annually (this is enough to load 50,000 logging trucks or build more than 20,000 houses a year) (Cushman 1997). The Forest Service stated that the portion

of land that would be set aside would make it unnecessary to list the Alexander Archipelago Wolf and the Queen Charlotte Goshawk on the Endangered Species Act. Conservation organizations criticized the plan and the failure to support listing of these species. The Alaskan Congressional delegation expressed its disappointment that more timber had not been open to logging (Cushman 1997). The 100- to 125-year cycle of cutting by the Forest Service assured that old-growth forests and their complex and diverse ecosystems will disappear.

The Forest Service held nationwide hearings during the summer of 2000 regarding a proposal that some 50 million acres of national forests be protected from road-building. This proposal specifically exempted the Tongass National Forest. The Forest Service plan would allow massive road construction and logging in the Tongass's remaining pristine forests. In a surprise decision prior to leaving office, President Bill Clinton authorized the inclusion of 9.3 million acres of the Tongass National Forest in the final plan; although delayed until 2004, this was an extremely important event, condemned by the Alaskan Congressional delegation (Hughes 2000). The plan calls for $13 to $20 million to be spent in Alaska creating jobs lost in the timber industry. The plan had drawn more than 1.5 million letters and e-mail messages, the overwhelming majority in favor of banning road-building. In spite of opposition to the designation of wilderness in this vast national forest, conservationists succeeded in obtaining a moratorium on logging of 9 million acres, pending the results of studies on whether they qualify for permanent protection under the Wilderness Act (Earthjustice Legal Defense Fund 2001).

Another huge national forest in Alaska, the Chugach, located at the headwaters of the salmon-rich Kenai River, has received far less attention than the Tongass, in spite of being the second largest of all US National Forests. In 1996, the Forest Service cut nearly 16 million board feet in this old-growth forest.

North America™s Forests: Page 15

The future of forests in the United States is at a dramatic turning point. During the summer of 2000, devastating wildfires broke out in the Western United States, primarily in national forests. More than 6.7 million acres burned, along with hundreds of private homes (Janofsky 2000). Within months, the Clinton Administration proposed a major new approach to the national forests, dictating extensive thinning of millions of trees and the removal of brush to prevent future wildfires (Jehl 2000). This plan was based on the theory that the fires were caused by too little logging, resulting in dense forests with underbrush that caught fire and spread uncontrollably. Pro-logging Members of Congress, western Governors and logging companies immediately endorsed the plan (Janofsky 2000, Jehl 2000). Some Governors wanted even more money for the program (Janofsky 2000). The proposed thinning would cost taxpayers $12 billion over 15 years (Jehl 2000). This was challenged by a report issued by the Congressional Research Service soon after the fires were extinguished, which concluded that there was no connection between the level of logging and wildfires (Egan 2000). Other critics included the Forest Guardians of New Mexico, who contended that the fires were the result of decades of industrial logging in which the largest trees were taken; it suggested that instead of thinning, logging subsidies be directed at badly needed projects to control soil erosion, protect water quality and enhance wildlife habitat (Hitt 2000). Environmental groups opposed the logging portion of the proposal as a tool for fire prevention (Janofsky 2000).

As the ideal example of how national forests should be managed, the Clinton Administration proposal pointed to an Arizona Ponderosa forest that had been thinned and did not burn. Ponderosa forests are not typical, however, of all forests, tending to be open with little understory. Other types of forests, such as old-growth temperate rainforests, are not open, and drastic thinning of their undergrowth would result in more, not fewer fires. Moreover, nutrients would be lost, erosion encouraged and wildlife habitat destroyed by such thinning. Dr. Paul R. Epstein (2000), a scientist with Harvard's Medical School Center for Health and Global Environment, concluded that the wildfires were precipitated by global warming, which caused the drought that dried out these forests, making them vulnerable to wildfires. Epstein proposed that the most important reaction to these fires would be to control global warming and

restabilize the climate system.

An extremely important policy statement was made by Forest Service chief Mike Dombeck in January 2001, when he ordered the protection of the largest and oldest trees on Forest Service land (Jehl 2001a). In explaining his decision, Dombeck said, "In the future, we will celebrate the fact that national forests serve as a reservoir for our last remaining old-growth forests and their associated ecological and social values" (Jehl 2001a). Only about 3 percent of national forests is old-growth forest, yet these forests are among the most important refuges for rare and endangered species. Dombeck's statement and the philosophy behind it are reminiscent of John Muir or Henry David Thoreau, an extraordinary reversal from the utilitarian view of forests as tree farms that has held sway since the beginning of the Forest Service. In fact, it had been Forest Service policy that the oldest and biggest trees be cut first (Jehl 2001b). The new Republican Administration and the Senate panel overseeing the Forest Service announced that hearings would be held on the new policy, which runs counter to the one backed by President George W. Bush (Jehl 2001b). Dombeck was asked to leave his job soon after President Bush took office. Logging in national forests has declined from 1989, when 12 billion board feet were cut, to about 3 billion board feet in 2000 (Jehl 2001b). Loggers are expected to lobby hard to cut these last old-growth trees because of the huge amount of dense wood they contain.

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Although Canada's forests are far more extensive, with greater amounts of old-growth, they are being logged at an extremely rapid pace. The 1980s and early 1990s witnessed the clearcutting of millions of acres of Canadian forests, from boreal coniferous woodlands to deciduous and mixed forests in the east to the ancient temperate rainforests of British Columbia's coast. The logging that has removed vast tracts of Canada's forests is a major factor in the decline of the continent's colorful and ecologically important wood warblers and other songbirds. British Columbia's mountainous terrain is not conducive to clearcutting because of erosion, but this has been the method used to raze hundreds of thousands of acres. Wilderness valleys with forested slopes have been denuded and the soil and debris washed into salmon streams and rivers, clogging and destroying them. The Bowron Valley in central British Columbia was turned into a moonscape in 1992 when 1,600 square kilometers were clearcut; efforts to replant this huge area have not been successful (Devall 1993). Habitat of the Grizzly Bear in British Columbia's high-altitude forests has been devastated along with its forest wilderness home elsewhere in Canada (Devall 1993).

Research on Sitka Spruce (*Picea sutchensis*) canopies on Vancouver Island, along the British Columbia coast, has produced 300 new species of insects, and scientists state that this environment will reveal hundreds more. According to one biologist, "We have a virtually unexplored biological frontier in our own backyard" (Moffett 1997). A highly unusual Sitka Spruce, called "Golden Spruce" (*P.s. aurea*), grows on Graham Island in the Queen Charlotte Islands to the north of Vancouver Island (DePalma 1997). This extremely rare color phase had only one known adult specimen in the wild, the result of a genetic quirk that causes chlorophyll to break down, giving the needles a golden yellow hue when exposed to sunlight (Comeau 1997). Standing 160 feet tall, and 300 years old, the Golden Spruce was known to the native Haida tribe, who revered it, as "kiidk'yaas," or ancient tree (DePalma 1997). (A color photograph of this dazzling tree was published in the *Canadian Geographic* magazine in May/June 1997.) The Haida believed that the tree would be admired until their last generation and that it held the spirit of a young Haida boy who survived, along with his grandfather, the demise of their village, which was destroyed by an angry Creator (Comeau 1997). As they walked away, the elder warned the boy not to look back, but the boy disobeyed and was turned into a tree that came to be venerated as the embodiment of the tribe's spirit (Comeau 1997).

In January 1997, a mentally unbalanced man swam across the sound to the island and cut the tree down. This caused shock and dismay among the Haida, who felt they had failed in protecting this most important part of their traditions and believed that its death predicted their own demise (Comeau 1997). Fortunately, a few cuttings had been

taken from this tree in 1986 by a horticulturist, who brought them to the Botanical Garden at the University of British Columbia and propagated them. Two 5-feet-tall, scrawny trees were produced, and they are all that remain of the magnificent Golden Spruce (DePalma 1997). The Haida took about 100 cuttings from the top of the felled tree and asked the scientific community to help save it. They accepted one of the two propagated specimens from the university (Comeau 1997).

Vancouver Island, just north of Washington state, is one of the most magnificent scenic areas in the world. The struggle to stop clearcutting of its ancient forests has become pitched. One highly endangered species resident on this island is the endemic Vancouver Island Marmot (*Marmota vancouverensis*), one of 11 species of marmots in the world, all native to the Northern Hemisphere (Nowak 1999). Much of the Vancouver Island Marmot's habitat has been destroyed by development for ski slopes and logging, which apparently removed important migration corridors between colonies. This exposed the marmots to predation and prevented the establishment of new colonies (Thornback and Jenkins 1982). Colony sites became isolated, and vacant areas were not reoccupied, causing inbreeding (Thornback and Jenkins 1982). The Federation of British Columbian Naturalists formed a Vancouver Island Marmot Preservation Committee to conduct surveys and publicize the need to protect the Vancouver Island Marmot (Thornback and Jenkins 1982), yet in spite of long-term studies, logging continued. Surveys in 1979 and 1980 found only 11 colonies with 50 to 100 individuals (Thornback and Jenkins 1982). A 1984 survey found 231 animals, and some captive breeding has been successful (Nowak 1999).

The *2000 IUCN Red List Species* lists the Vancouver Island Marmot as Endangered (Hilton-Taylor 2000). It is also listed as Endangered by the US Endangered Species Act, and as Critically Endangered by the British Columbia Conservation Data Center of the province's Ministry of Environment. The Vancouver Island Marmot has been ranked in the most endangered category by the Center, as having few remaining individuals, and since this remnant population is continuing to decline, its extinction has become likely. By 1995, 11 colonies had declined to only eight, and the 1984 population of 231 animals had declined to only 150 animals. Biologist Andrew Bryant, chief scientist of the Marmot Recovery Foundation, conducted his Master's Thesis on the species and has continued to monitor it, according to the British Columbia Conservation Data Center. The population declined to a critical level in the late 1990s, and there are plans to take more animals into captivity to attempt captive breeding for future releases into protected habitat. In 1999, researchers found only 62 marmots left in the wild (NGS 2000). They took 27 into captivity for breeding programs. Bryant stated that the major threat to these animals was clearcutting, which greatly reduced their food supply; they are also vulnerable to predators (NGS 2000). The long-term plan is to reestablish these marmots in three separate sites and build populations up to 400-600 animals (NGS 200).

Vancouver Island's panoramic beauty is displayed in the 1994 film, fiRainforest of the Pacific Northwestfl (see Video, North America section). Aerial views of undisturbed forest and the majestic Clayoquot Sound contrast with large stretches of clearcut forest. Trees up to 270 feet tall and more than 1,000 years old grow on Vancouver Island, but less than one-third of the old-growth forest remains; at the making of the film only 4.5 percent of the forest was protected. The British Columbian government appointed a panel to recommend revisions to the logging plan for Clayoquot Sound and, to the delight of conservationists, issued recommendations in 1995 banning clearcutting and proposing strong streamside protections and so many safeguards that very little logging will be allowed (SCLDF 1995). In 1995, the British Columbian government announced that it would adopt all the recommendations made by the blue ribbon Science Panel. All commercial logging in pristine areas has been deferred until biological inventories are completed, according to the Rainforest Action Network (RAN). This does not mean a permanent end to logging in this beautiful Sound, and conservationists will need to continue the fight. The native-run Clayoquot Sound First Nations leaders are apprehensive that they may be pressured into joint logging ventures with timber companies, and they issued an unequivocal declaration calling for an end to commercial logging in all old-growth forests (Rosmarin 1995).

Forty miles north of Vancouver, old-growth coastal forests are being destroyed by commercial loggers to make way for urban and suburban growth. The Squamish River cuts through these forests and provides one of the great wildlife spectacles in North America. When salmon disappeared from almost every river of the Northwest and

pollution killed off fish in many northern states, Bald Eagles migrated north to the Squamish River (Nickerson 1995). Almost 4,000 Bald Eagles from as far away as Wisconsin and the Rocky Mountains winter along the river, feeding on spawning salmon (Nickerson 1995). "Americans are strange," a Squamish Native American remarked, "They revere the eagle as the pride of their country, then ruin his home and make him so hungry he flees to Canada" (Nickerson 1995). Yet this sanctuary is now threatened. A 600-acre industrial park at the heart of the winter roosting grounds is planned by local officials, and logging has removed much of the forest already (Nickerson 1995). The Nature Conservancy began acquiring parcels of land for the establishment of Canada's first sanctuary for Bald Eagles (Nickerson 1995). The goal of conservationists is a preserve of 2,700 acres to protect this important feeding area (Nickerson 1995).

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The white bears of Canada live along 1,000 square miles of rainforest on the British Columbian coast and off islands. Their main breeding island, Princess Royal Island, harbors the largest number of these bears, which are a rare color phase of the Black Bear. The percentage is even lower on other islands (Russell 1994). The world population of these bears is estimated at only about 400 (NRDC 2001). A delightful book, *Spirit Bear. Encounters with the White Bear of the Western Rainforest*, by naturalist Charles Russell, recounted his visits to the island with two filmmakers, Jeff and Sue Turner, who were working on "Island of the Ghost Bear." Russell, who has been studying and helping bears of many species throughout his life, wanted to write a book about the spirit bear to obtain sanctuary status for this island and its bears. The white bears on the island have been protected for thousands of years, first by the Native Americans, and now by the British Columbian government. They are so tame that Russell was amazed, having never encountered such friendly bears of any species. A young white bear came to inspect Russell and the filmmakers soon after they arrived, peering into their camera lens, leaving nose prints on the lens (Russell 1994). This bear would sit down near them, sometimes seeking their protection when larger Black Bears tried to take away salmon he had caught (Russell 1994). On one occasion, Russell followed the bear back into the forest to see where he went. After a long walk through the rainforest, the bear found a soft area covered in bright green moss and decided to take a nap. He was so trusting that he went to sleep with Russell watching him only a few feet away. While asleep, the bear seemed to be dreaming, his eyes moving, legs twitching, and sometimes grunting (Russell 1994). Russell's book is illustrated with many photos of the bear fishing, sprawled on his back in the forest, and climbing about the rocks. This bear let himself be scratched with a stick and even tried to wrestle with Russell and Jeff Turner. Russell and the Turners left the island but returned after a year, and the bear came to greet them, sitting down a few feet away as if they had not been gone at all (Russell 1994).

The entire range of this bear is slated for logging. The Black Bears living on these islands, which carry white bear genes and are only a bit less tame than the white bears, are hunted under British Columbian law, which allows two bears per hunter each season. When they were filming the bears, some Swiss, German and Austrian hunters had arranged a bear hunt (Russell 2000).

The film, fiGhost Bear,fl shown on PBS's Nature series in 1994, captured an island little changed for 10,000 years, never logged and teeming with wildlife. Black wolves, mergansers, Beavers, salmon and Bald Eagles live in this mossy, verdant forest with towering trees. The filmmakers urged protection for the bears and the forest. Other defenders of this bear and its forest are the members of the Kitasoo and Gitga™at Indian tribes of British Columbia, who believe that the white bears were created by a raven who came from heaven and decreed, "The white bears will live here forever in peace." The tribe wants to create a park of the entire area to protect the bears and the rainforest. Logging proceeded, however, within the proposed park, and a logging company cut a road through one island's ancient rainforest and the ancestral Kitasoo deer-hunting grounds. The Rainforest Action Network (RAN) began in the mid-1990s to help create a sanctuary, which is opposed by the British Columbian government. Twenty million acres of rainforest in the province may be cut, and RAN is campaigning to convince US customers to cancel contracts

and refuse to buy products from these ancient forests (Rosmarin 1995).

A Canadian couple, Ian and Karen McAllister, have formed an organization, Rainforest Conservation Society, to preserve the habitat of the Ghost Bears and the Great Bear Rainforest. Their book, *The Great Bear Rainforest, Canada's Forgotten Coast*, published in 1997 by Sierra Club Press, eloquently describes this magnificent region and their work to help preserve it. The Natural Resources Defense Council (NRDC), headquartered in New York, took on the cause in 2000, urging a consumer and commercial boycott of International Forest Products (Interfor), a logging company that is cutting the old-growth forests in the heart of 18 untouched rainforest valleys in the Great Bear Rainforest. As the company was about to clearcut East Creek on one island, it was stopped by construction of a tribal longhouse by the Gita™at Tribe at the mouth of the creek, aided by NRDC, which forced the company to suspend its plans (NRDC 2001). Negotiations between conservation groups and six logging companies, including Interfor, had appeared to achieve protection of the Great Bear Rainforest, but Interfor pulled out of the agreement and recently began logging within the habitat of the white bears. This devastation of a magnificent environment does not even make economic sense, as there could be a sizeable market for videocam views linked to a satellite of these enchanting bears and their mossy, green forests, paid for by viewers around the world for a long-term profit far exceeding that which will accrue to the loggers. The Giant Panda is also a charismatic species, and conservation donations from zoos now total $10 million a year or more to preserve the species™ habitat. The white and black bears of this wilderness deserve no less.

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Further inland, the Wood Buffalo National Park, bordering Alberta and the Northwest Territories, is the sole breeding ground of the endangered Whooping Crane (*Grus canadensis*). This enormous park, designated a United Nations World Heritage site, was logged in large clearcuts from the end of World War II until 1992, a tragic loss of old-growth boreal forest (Devall 1993). The logging was stopped by a lawsuit brought by the Sierra Club Legal Defense Fund (now Earthjustice Legal Defense Fund) in conjunction with the Canadian Parks and The Wilderness Society. The suit was based on the Canadian National Parks Act, which states, "The National Parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations" (Devall 1993). The Peace River, flowing through Wood Buffalo, is so contaminated by dioxin from the Daihowa pulp mill upstream that natives no longer eat the fish, their major food staple, from the river (Devall 1993).

By the end of 1988, one-third of the land surface of Alberta, Canada-- 221,000 square kilometers--had been logged. Much of Saskatchewan's former forested land--more than one million hectares--has been clearcut and not replanted, nor has it regenerated naturally (Devall 1993). Manitoba, south of Hudson Bay, protects less than 2 percent of its territory from development and logging. In 1989, the Manitoba government opened up an area the size of Ohio, 108,000 square kilometers, to logging (Devall 1993). Logging in Manitoba, Saskatchewan and Alberta fueled $10 billion in new pulp mills, major water and air pollution sources (Devall 1993).

Eurasian Temperate Forests

The Siberian Tiger's Domain
Land of the Giant Panda
Lost Forests of the Mediterranean and Europe

Eurasian Temperate Forests: The Siberian Tiger's Domain

Russia's coniferous forests form the major part of the Eurasian taiga, a mixture of spruce, birch and other evergreens, covering 3 million square miles, two•thirds of the country's land surface (Sparks 1992). It is the world's largest forest of any type, more than twice the size of the Amazon rainforest (Stewart 1992). Russia's taiga makes up half of the world's total area of coniferous forest and about one-quarter of the entire forested area of the world; the Siberian portion alone is one•third larger than the whole of the United States (Sparks 1992). The forested land east of the Ural Mountains covers 5 million square miles (Linden 1995). Further south, deciduous trees mix with aspen, birch and alder (Sparks 1992). This entire, vast forest may once have been the domain of the Siberian Tiger (*Panthera tigris altaica*), as its fossilized bones have been found on Lyakhov Island off the north coast of Siberia (Matthiessen 2000).

The vast expanses of taiga forests were opened up to international logging after the dissolution of the USSRF. By the early 1990s, about 304 million acres, two•and•one•half times the size of France, had been clearcut (Stewart 1992). Each year an additional 12 million acres are logged (Lean and Hinrichsen 1992). Commercial exports of Siberia's logs to the United States have been encouraged by various corporations and the US Department of Commerce. Logging has also been intense in Russia's Far East, an area of great biological diversity, with many resident endangered species.

A nearly pristine and stunningly beautiful part of Russia is the Kamchatka Peninsula in the Far East, jutting into the Pacific Ocean. This area has 29 active volcanoes, wild rivers, hot springs, and beautiful forests. An endemic tree, the Kamchatka Fir (*Abies gracilis*), grows only on this peninsula. A relict of pre-Ice Age coniferous forests, it is a silvery fir with soft needles, which grows to about 70 feet in height; this once widespread tree is now restricted in range (Sparks 1992). The forests of Kamchatka are being heavily logged (Meulenaer and Vaisman 1996). Another threat is gold mining, as $10 billion worth of gold is thought to lie under the forests and lakes of the Peninsula (Specter 1997).

The Kamchatka Sable (*Martes zibellina*) is larger than sables in other parts of Russia and was nearly trapped to extinction in the 19th century (Stewart 1992). The Sable's habitat is dominated by Stone Birch (*Betula ermani*) forests with thick, grassy undergrowth covering the mountain slopes; some of these trees grow to be 600 years old (Stewart 1992). Mountain Ash provide berries which, along with an occasional fish, supplement the Sable's diet of voles (Stewart 1992). Unfortunately, anti-trapping restrictions are not being enforced in Russia's Far East, even in nature reserves. The Kronotsky Nature Reserve, covering 3,860 square miles on the peninsula's east coast, shelters 700 species of tundra, taiga and mountain plants, with a number of unusual endemic plants, including the beautiful Kamchatka Rhododendron (*Rhododendron kamchatkensis*), which has miniature red blooms (Sparks 1992).

The magnificent Siberian or Amur Tiger is the largest of all wild cats. Only a few hundred years ago, its realm extended from northern Manchuria west to Lake Baikal and south to North Korea and northeastern China (Matthiessen 2000). Its range shrank over the centuries as a result of hunting, persecution, loss of prey species and habitat. Today it is restricted to the extreme southeastern Maritime Region in the Amur River basin east of Manchuria, west of Sakhalin Island (Miquelle *et al.* 1999). During the 1980s, the Soviet government established a series of reserves for the Tiger, but heavy logging and hunting in the region caused declines in its major prey species, boar and deer. Only 5 percent of the Siberian Tiger's habitat is protected in reserves, according to Evgeny Smirnov, a Russian biologist who studies Tigers (Gourevitch 1995). Moreover, a trade in Tiger bones and other body parts for Traditional Medicine has resulted in the killing, often brutal, of thousands of Tigers throughout their range from India east and south to Indonesia (see Trade chapter).

Siberian Tigers require very large territories. In Sikhote-Alin, their major protected reserve, there are only 10 to 15

resident adults on 400,000 hectares (988,400 acres) (Smirnov and Miquelle 1999). Such large home ranges make them extremely vulnerable to habitat loss, especially the fragmentation of forests by logging. This region™s volcanic peaks rise 5,000 feet from the sea, and forests are crisscrossed by rivers and dotted by lakes. Northern and southern forests meet here, harboring a myriad of tree species. Tall Korean Pines (*Pinus koreansis*) mingle with oaks, maples, walnuts and birches, and unlike the typical Siberian taiga, shrubs and undergrowth are luxuriant (Stewart 1992). These trees reach heights of nearly 150 feet and produce a great volume of cones, providing food for Wild Boar, Brown Bear, Manchurian Moose, and the endemic Ussurian Asiatic Black Bear (*Selenarctos thibetanus ussuricus*). Korean Pines have been so heavily logged outside the reserve that the species is now threatened; although it is protected, illegal logging still occurs (Bohan *et al.* 1996).

A highly unusual type of dark•barked, slow•growing birch grows here. Known as the "Iron Birch" (*Betula schmidtii*), its wood is reputedly so heavy that it sinks in water (Stewart 1992). The Primoryi Province, in which this preserve is located, harbors more than 150 species of trees and shrubs. The meeting of northern and southern forests in this region has resulted in a rich diversity of wildlife. The Ussuri Sika deer (*Cervus nippon hortulorum*) lives alongside the endangered Goral (*Naemorhaedus goral*), a goat•like ungulate native to mountains west to the Himalayas. This is the northern edge of the Leopard's range. The Amur Leopard (*Panthera pardus orientalis*) is a highly endangered subspecies, threatened by both habitat loss and poaching. Lynx and Common Otter are also native. The Dhole (*Cuon alpinus*), a threatened wild dog native to more southerly regions west to India, may also be native to the Sikhote•Alin Preserve. This extraordinarily rich diversity of predators and prey is at great risk from overhunting and logging, however.

As many as 340 species of birds have been recorded in Sikhote•Alin (Stewart 1992), including two endangered waterbirds, the Red-crowned Crane (*Grus japonensis*) and the Oriental White Stork (*Ciconia boyciana*) (Collar *et al.* 1994). A species of ginseng (*Panax ginseng*) grows in the undergrowth and is valued by the indigenous Udege people and others as an invigorating tonic, making it the "root of life" in their folklore. They believe that the ginseng is guarded by the great Siberian Tiger, and shrines are erected to the Tiger, who is believed to possess near•magical powers (Stewart 1992).

In 1991, the Hyundai Corporation of South Korea signed a 30•year contract to cut 500,000 acres of virgin forest on the Pacific slope of the Sikhote•Alin range (Schafer and Hill 1993). By the end of 1992, the area had been clearcut, and Hyundai began logging in the Bikin River Basin, the last pristine river valley in the region (Schafer and Hill 1993). In the Bikin, a small population of Udege live along the river's forested banks, as they have for hundreds of years, subsisting on local wildlife (Schafer and Hill 1993). These people have opposed the entry of the loggers, filing suit to stop the logging, threatening to shoot at logging trucks and removing markers from trees slated for cutting (Schafer and Hill 1993). Their protests succeeded in stopping the logging, negating the original agreement; Hyundai continues, however, to try to gain access to the Bikin forests (Bohan *et al.* 1996). This 600,000-acre watershed of the Bikin River is among the last virgin forests in Ussuria (Matthiessen 2000). A plan by the US Weyerhauser Corporation to cut an area of virgin forests the size of Delaware was thwarted by conservationists, and this forest has been declared a nature preserve (Nunn 1996).

Some 10 million acres of Tiger habitat are being clearcut every year, and members of the Siberian Tiger Project, composed of US and Russian biologists, are proposing alternate methods of timber harvest for the region (Quigley and Hornocker 1994). The native deer and boar, upon which the Tiger depends, are being hunted out of many areas by local villagers and professional poachers, who sell their bones and antlers for the Chinese Traditional Medicine trade. In 1995, the Russian government issued a decree "On Saving the Amur Tiger," which called for a specific plan and schedule to implement Tiger protection efforts (Galster 1996). In response, the Russian-American scientific team formulated a plan the same year to protect all existing Tiger habitat with connected reserves, new national parks, multiple use zones and ecological corridors linking them. It would be the world's largest sanctuary, preserving old-growth Korean Pine and designating various zones in this immense area, which extends from north of Khabarovsk south to Vladivostok in a mosaic of connected land (Galster 1996). The plan also called for a new national Tiger census, which was carried out in early 1996 and found more Tigers than previously assumed, an estimated 330 to 371

animals. The proposed protection plan, when combined with the Bikin traditional reserve and a large region a US government agency is helping to protect through multiple use, would preserve about 26 percent of existing habitat of the 156,000 square kilometers used by Siberian Tigers in Russia (Miquelle *et al.* 1999). The remaining area is either scheduled for logging or agricultural development. The Tiger biologists are urging that all Tiger habitat be included in a national protection plan, as signs of Tigers have been seen in 90 percent of the habitat (Miquelle *et al.* 1999). Coexistence between Tigers and people is essential. This would mean easing human hunting pressure on its prey, primarily Elk and Wild Boar, which have become rare, a major cause for the Tiger™s need of such large territories. Moreover, Tiger poaching needs to be stopped, and Tigers need access to river valleys, which they use for hunting and movements. Most of these have been taken over for human use.

The Siberian Tiger Project was the subject of a 1995 National Geographic film, "Tigers of the Snow," which included the first filming of a baby Siberian Tiger being weighed and examined by biologists in its wild den. The magnificent scenery of this coastal region was filmed from an aircraft, and areas of clearcutting were in stark contrast to the unbroken forests. The film also noted the sad end to a young Tiger hit by a logging truck. These trucks, loaded with giant tree trunks, thunder through the beautiful valleys. The Siberian Tiger Project is the first research study involving radio-tracking ever undertaken of the Siberian Tiger, and it is revealing new information on its range, behavior and habitat needs. Should the reserves be set aside, Siberian Tigers will be the first race or population of Tigers to become stabilized and perhaps increase at a time when all other populations are in drastic decline.

An eloquent book by Peter Matthiessen (2000), *Tigers in the Snow*, focuses on this research and the future of all Tigers. Anti-poaching work is helping to stem the decline of both the Tiger and its prey, but until its habitat is secure, this once proud cat, master of its domain, will remain beleaguered and under constant threat. Its world has become a battleground, filled with the screeching of power saws destroying the forests it needs to survive, and the constant threat of poachers. As a keystone species at the top of its food chain, the survival of the Tiger is "the best indicator of the health of the ecosystem as a whole" (Matthiessen 2000). Without the Tiger, the deer and boar will become slow, small and overpopulated, destroying their habitat as they have in Europe, where most predators have been eliminated. This is a crucial turning point for the species, whose tropical populations may not survive long. The Siberian Tiger inhabits a world without high human populations, a still-extensive forest habitat, and is the subject of a strong conservation program. The many people who are dedicated to saving it may succeed. In the words of Maurice Hornocker, an overseer of this research project, "One day it will be culturally unacceptable to kill Tigers anywhere for any reason" (Matthiessen 2000).

Eurasian Temperate Forests: Land of the Giant Panda

China's once extensive forests have declined over the centuries as human population increased. In south-central China, temperate forests of many types are watered by the five great rivers of Southeast Asia: the Mekong, Irrawaddy, Yellow, Yangtze and Salween (Mittermeier 1999). This is botanically the richest temperate region in the world, twice the size of California with half of China's plants--12,000 species, of which 3,500 are endemic (Mittermeier 1999). This is the home of the Giant Panda (*Ailuropoda melanoleuca*). Fewer than 1,000 of these black-and-white bears remain in small, scattered populations. When climates were cooler during the Ice Ages 12,000 years ago, Giant Pandas had a far larger distribution, covering much of central and southern China and bordering areas of Burma. As climates warmed and human populations took over much of their habitat, they declined in numbers, and their bamboo forests retreated. Today, Giant Pandas remain only in three provinces, with the largest number in Sichuan. Between 1974 and 1989, their habitat was halved as a result of logging and settlements, from 20,000 square kilometers to 10,000 square kilometers (Mittermeier *et al.* 1999). Satellite studies of their major reserve, Wolong Nature Reserve, found a dramatic decline in forest cover from 1965 to 1997 as growing numbers of people living in the reserve cut deciduous trees and bamboo for firewood (Revkin 2001). During the last decades, with international attention focused on this extremely charismatic animal, reserves have been set aside. Twenty reserves have been established in the

remnants of the Giant Panda's habitat, but the species has continued to decline as destruction of forests turn the reserves into islands surrounded by clearcut hillsides. Many Pandas have starved to death when their bamboo forests were cut or underwent a cyclical die-off. Prior to this deforestation, when local bamboo forests died off, Giant Pandas were able to wander widely in search of other bamboo. Their habitat has decreased so much that they are now at the mercy of local conditions within each reserve (Mittermeier 1999 *et al.* 1999).

A long•term study of this species by Dr. George Schaller, of the New York-based Wildlife Conservation Society, arrived at the pessimistic conclusion that the Giant Panda was headed inexorably toward extinction (Schaller 1993). In his 1993 book, *The Last Panda*, Schaller wrote a scathing and unflinching analysis of the failure of existing conservation programs. Among his conclusions was that almost all of the millions of dollars raised around the world to preserve this most popular of all animals had been wasted while wild Giant Panda populations dwindled. His research revealed that Pandas were readily taken into captivity during bamboo die•offs when, in fact, enough bamboo still remained to supply their needs (Schaller 1993). Most of the funds were spent on building dungeon-like breeding and holding compounds rather than on saving its ever•dwindling habitat or hiring wardens to prevent poaching (Schaller 1993). The Wolong Reserve, which covers 780 square miles, was the location of his research area. Wolong had 4,200 people living within its borders in 1989, who were cutting trees and setting snares to kill wildlife for meat, musk and skins (Schaller 1993). In eight years alone, 14 square miles of the Wolong forest were destroyed, and an unknown number of Pandas died in cruel wire snares (Schaller 1993).

Only time will tell whether the urgent habitat and anti•poaching needs of the Giant Panda will be met, or whether funds meant for its conservation will continue to be spent on breeding compounds. Seventeen forest corridors are planned to link fragmented habitat, but breeding and holding compounds continue to be built, with a goal of 32 stations (Williams 1994). A dedicated Chinese scientist, Pan Wenshi, who has studied these animals for decades, helped save the habitat of some 80 Pandas in these mountains when the high•pitched whining of chain saws was within earshot (Wenshi 1995). The National Geographic Society filmed the mother Panda that Pan Wenshi had studied throughout her life, Jiao Jiao, and her tiny mouse•sized cub when only a few days old (see Video section). This cub, a female he named Xi Wang, meaning Hope, grew into a healthy young Panda and, when four months old, took her first shaky steps out of the warm den (Wenshi 1995). As she grew older, Xi Wang took naps lying on her back in the tops of pine trees, watching her mother as she fed in the forest (Wenshi 1995).

If forest corridors are not soon set aside linking the reserves to one another to allow free movement of Pandas, the species will probably fade gradually to extinction from inbreeding (Lean and Hinrichsen 1992). One source of funding to preserve habitat is the Chinese government loan program, under which Giant Pandas are sent to foreign zoos for periods of up to 10 years. Various zoos in the United States have arranged such loans, paying the Chinese government $1 million per year per zoo, and these funds must be applied to conserving the species in the wild under supervision of the US Fish and Wildlife Service. A pair in the San Diego Zoo produced a healthy female cub in 1999 through artificial insemination. Other pairs were acquired by Zoo Atlanta and the National Zoo in Washington, DC, in 2000. Few Giant Pandas breed naturally in zoos. This funding and the new attention directed at conserving these highly endangered and endearing animals may turn the tide in China to protecting their habitat. If successful, it will also spell survival for thousands of rare Chinese plants and animals that inhabit the Pandas™ forests.

Xi Wang, the Giant Panda studied by Wenshi, inhabits the Qin Ling Mountains, haven for a wide diversity of rare plants. One mountain alone, the 12,359-foot Taibai Mountain, has 150 endemic species of plants, among them the Qin Ling Mountain Fir (*Abies chenensis*) (Ji 1990). Two varieties of this species are listed by the *1997 IUCN Red List Plants* (Walter and Gillett 1998). A neighboring mountain, the Shennongjia, is known as a "Treasure House of Plants" because of the many unusual and ancient species here (Ji 1990). In Hubei Province in the same region is the Dawn Redwood, a deciduous tree which is a close relative of the North American Coast Redwood and Sequoia but far more ancient in lineage (Ji 1990). Until 1941 when a few groves were discovered by Chinese botanists, the Dawn Redwood was known only from Jurassic fossils (MacKinnon 1996). Small populations survive in Sichuan, Hubei and Hunan provinces, but the species is considered Endangered by the International Union for the Conservation of Nature (IUCN) (Walter and Gillett 1998) and only about 1,000 trees may survive in the wild (Dyer 2000). This tree grows to

a height of about 115 feet, its delicate pinnate leaves turning golden in the fall. As the sole member of its genus, and a living example of trees that grew in the age of dinosaurs, it is considered a great botanical treasure.

Its seeds have been planted in many parks and botanical gardens around the world. John Williams, the award-winning composer, became fascinated with a Dawn Redwood growing in Boston's Public Garden (Dyer 2000). "It not only looked lovely, but it seemed animate, even intelligent," he said (Dyer 2000). By chance, he met a retired Harvard University botanist, Dr. Siu-Ying Hu, and praised the tree on a walk through the Public Garden. Hu pointed out that he had planted this very tree back in the 1940s, having brought a bag of seeds to America when he arrived from China (Dyer 2000). The Dawn Redwood inspired Williams to compose a musical piece entitled "Tree Song" for harps, keyboards, flutes and delicate percussion. It was performed by the Boston Symphony Orchestra at the opening of the summer concert series at Tanglewood, Massachusetts, in July 2000 and recorded on CD (Dyer 2000).

The extraordinary Dove Tree (*Davidia involucrata*) was named after its discoverer, Pere Armand David, a French missionary who traveled in China in the 19th century and named hundreds of animals and plants. Its white leaves are up to 6 inches long and 3 inches wide, resembling a flock of doves taking flight (Schaller 1993). These trees are quite rare in China, after centuries of deforestation (Walter and Gillett 1998). Even in 1900, when American botanist E.H. Wilson went to China to find seeds from this tree, he traveled six months before he even met someone who had ever seen one (Stocker 1997). When Wilson finally found a Dove Tree, only a stump remained: it had been cut and the wood used to build a house. He later found 10 wild specimens and brought back seed to Harvard University's Arnold Arboretum (Stocker 1997). This species, too, has ancient origins and once dominated prehistoric forests (MacKinnon 1996). Like the Dawn Redwood, it was rescued from extinction and is now cultivated in nurseries and botanical gardens (Stocker 1997).

Many of these plants and trees share the habitat of the Giant Panda, and forest reserves would ensure their survival. A number of endangered mammals that have disappeared from other regions as a result of hunting and habitat loss can be found in Wolong and other Giant Panda Reserves. The Red Panda (*Ailurus fulgens*), thought to be a relative of the Giant Panda, is a rare native, as are the Golden Monkey (*Pygathrix roxellanae*) and the Takin (*Budorcas taxicolor*), a goat•like ungulate. All three are endangered species and declining as the forests are cut. An endangered bird, the Sichuan Partridge (*Arborophila rufipectus*), is restricted to an area of less than 100 square kilometers in south-central Sichuan, where fewer than 2,000 birds survive (BI 2000, Collar *et al.* 1994). Its old-growth broadleaf forest is being felled at a rapid rate, and people enter its habitat to collect bamboo shoots in its breeding season, disturbances that are driving these birds toward extinction (BI 2000). Twenty-six other species of pheasants inhabit this part of south-central China, including the most iridescent birds in the world, the monals. The threatened Chinese Monal (*Lophophorus lhuysii*) inhabits rhododendron and high-altitude coniferous forests and is in decline as a result of logging and hunting, which have been facilitated by the construction of logging roads (BI 2000). The male Chinese Monal has dazzling plumage in an array of emerald green, purple, coppery-golden, purplish-green and white, while the female is more subdued in gray and rufous-brown. The creation of reserves for the Giant Panda have aided this bird's survival, as
several are within this bird's range (BI 2000).

China's 25,000 native plant species make up 11.4 percent of the world's plants, including many ancient ones (MacKinnon 1996). The Ginkgo (*Ginkgo biloba*) has been on Earth for 200 million years; this tree grows wild in scattered locations in China, indicating that it was once far more widespread and was eliminated by logging over the centuries (MacKinnon 1996). In prehistoric times, Ginkgoes grew throughout the world but were thought extinct until a few trees were found in remote forests (MacKinnon 1996). Its unusual wide, lobed leaves turn yellow in the fall before falling. This tree has been considered sacred by the Chinese for centuries and is grown in temple gardens and other religious sites. Extracts are sold around the world as an herbal stimulant. In the Himalayas, giant cypresses (*Cupressus*) grow to immense size when protected by Buddhist temples; one specimen measures almost 20 feet in diameter and is estimated to be 2,000 years old (MacKinnon 1996). Entire forests of these giant trees also grew on Taiwan, where only massive stumps remain (MacKinnon 1996). Stephen Spongberg, Curator at the Arnold Arboretum, has studied China's native trees and found numerous species to be extinct in the wild (Stocker 1997).

Antique Chinese furniture sought by collectors is often made from the wood of trees that are now extinct, and some trees are so rare that most Chinese botanists have never seen them in the wild (Stocker 1997).

China has more forest types than any country in the world. In the far north, taiga dominates. Conifers, birches and oaks blend into temperate coniferous forests in the northeast. Further south, the Giant Panda's habitat is temperate, evergreen forest. Himalayan forests occur in the west, and in the south, tropical monsoon rainforest prevails (Ji 1990). Unfortunately, very little virgin forests remain in the country, other than in high altitude and remote areas (Ji 1990). In the Giant Panda's highly diverse habitat of south-central China, less than 10 percent of the forests remain in pristine condition (Mittermeier *et al.* 1999). The destruction of these forests has been going on for centuries. During the 19th century, Pere Armand David lamented its destruction:

> *From one year's end to another, one hears the hatchet and the axe cutting the most beautiful trees. The destruction of these primitive forests, of which there are only fragments in all of China, progresses with unfortunate speed. They will never be replaced. With the great trees will disappear a multitude of shrubs and other plants which cannot survive except in their shade; also all the animals, small and large, which need the forest in order to live and perpetuate their species . . . They have the right to life and we annihilate them and brutally make existence impossible for them*
>
> Pere Armand David, 1875

In many parts of China, virtually no natural habitat remains, as centuries of human habitation and agriculture have replaced native vegetation and wildlife. One can travel for 1,500 miles in east•central China, for example, and see a landscape covered entirely with agricultural fields and villages, devoid of wildlife (Schaller 1993). Deforestation caused massive floods in the summer of 1995, when the Yangtze River, the country's longest, flowing from central China east to Shanghai, overflowed its banks. More than l.3 million people were displaced by the flooding, 900,000 houses collapsed, 2.7 million acres of crops were destroyed and 1,200 lives were lost (AP 1995). The economic losses were estimated at $4.4 billion. Each year these floods worsen as development covers the region, removing all natural flood controls (AP 1995). The last forests of any extent in China can be found in the northeast, and in 1987, fires destroyed 18 million acres (an area the size of Scotland) as well as 12 million acres in adjacent Russia (Schaller 1993).

Pere David's Deer (*Elaphurus davidianus*), named for its discoverer, and was once common in the northern forests and marshes. Hunting nearly eliminated the species, and to prevent its extinction, Chinese emperors kept the surviving population in a walled imperial hunting park near Beijing for more than 1,000 years. Even this population was killed by soldiers and villagers in the 1900 Boxer Rebellion, however; fortunately, some had been taken to England and kept by the Duke of Bedford on his estate (Schaller 1993). In 1985, 22 of these deer were returned from captive populations to the same walled park in China, now reduced from 150 square miles to 440 acres (Schaller 1993). Several other herds have been reintroduced elsewhere in China, numbering some 600 animals (MacKinnon 1996).

Reverence for nature in China dates back many thousands of years and is an integral part of the culture of this ancient country. It may now be reemerging. The 1979 Forest Law contained strict regulations on logging and required 40 percent forest cover in the mountains and 30 percent nationwide. This was strengthened in 1988 with a ban on logging in Yunnan and Sichuan, and legal protection was accorded to 389 plant and 206 animal species (Geatz 1999, Mittermeier *et al.* 1999). Reserves are being set aside throughout the country, increasing from 44 in 1956 to 600 in 1991, with a goal of 800 reserves protecting 5 percent of the country (Schaller 1993). This is indeed laudable in the most populous country on earth, and this eleventh-hour commitment is preserving many remnants of the once diverse and abundant natural heritage.

In practice, however, logging and firewood cutting tend to far exceed reforestation or preservation of forests in reserves or parks. Heavy livestock grazing by herders, who also clear forests for pasture, is devastating delicate forest

habitats (Mittermeier *et al.* 1999). Logging trucks carrying the trunks of the last remaining stands of old-growth forest can be seen in many areas. These deforested areas do not tend to regenerate because fires and grazing by goats kill the saplings (Mittermeier *et al.* 1999). During the late 1990s, The Nature Conservancy began a major project to study the biodiversity of the southern province of Yunnan, whose ecosystems range from alpine to subtropical forest (Geatz 1999). Certain tribes of this region have a strong tradition of conservation, and the provincial government has welcomed the help of this organization in helping to protect their natural heritage. Its 2000 report, "Conservation and Development Master Plan for Northwest Yunnan," includes recommendations for the protection of biodiversity, regional planning and resource development to provide ideas for non-destructive economic projects, such as growing plants for medicinal and ornamental purposes as an export commodity and developing ecotourism for this spectacular region (Geatz 1999, The Nature Conservancy 2000).

The future of China's forests and its tremendous biological diversity are greatly affected by its enormous human population of more than 1.2 billion people, whose growing needs encourage heavy hunting of its depleted deer and ungulate populations and large livestock herds, as well as excessive tree cutting for firewood (Mittermeier *et al.* 1999). Various international conservation organizations are working to help China in assessing its diversity and the threats to it, and to encourage enforcement of its 1982 Constitution, which states that the nation must protect and improve its environment and ecosystems, prevent pollution and protect precious animals and plants (Mittermeier *et al.* 1999).

Asia's beautiful pheasants and partridges are disappearing rapidly as their forests are cut and many are hunted for meat. Partridges and pheasants are found from the Himalayas to sea level tropical forests throughout most of Asia. They have declined dramatically, however. Of 22 species of Asian partridges, 15 species, or 68 percent, are listed by BirdLife International in *Birds to Watch 2: The World List of Threatened Birds* (Collar *et al.* 1994). An even higher degree of threat is suffered by the many spectacular pheasants. Of the 52 species of Asian pheasants, 38 species, or 73 percent, are threatened by the destruction of forests and hunting by the same authorities (Collar *et al.* 1994). Some endangered Himalayan pheasants include the Tibetan Eared Pheasant (*Crossoptilon harmani*), White Eared-pheasant (*Crossoptilon crossoptilon*), Cheer Pheasant (*Catreus wallichi*) and Elliot's Pheasant (*Syrmaticus ellioti*) (Collar *et al.* 1994). They show a great variety in their colorful and iridescent plumages, rivaling birds-of-paradise in beauty. Their relatively large size and brilliant plumage make them vulnerable to hunters, and they have not been studied intensively in the wild to determine habitat size and other requirements for their survival. Very few species have been protected in parks and reserves.

The mixed hardwood forests that once cloaked the Himalayas, studded in many areas by native rhododendrons, have been decimated during this century. Some 57 Asian rhododendrons are listed by the *1997 IUCN Red List Plants*. The deforested steep slopes are now prone to erosion by the monsoon rains that arrive annually. Heavy rains bring huge landslides and floods. Tree cutting, primarily by people gathering firewood or clearing land for agriculture, has been particularly severe in the Indian, Pakistani and Nepalese Himalayas. The once unbroken stands of oak and pine have become fragmented and totally absent in many areas. Human populations have risen over the past century to levels far above carrying capacity of this delicate region.

The Ganges River, which flooded only once every 50 years prior to deforestation, now floods every few years since the Himalayan forests that retained the water throughout the years have been logged (Lean and Hinrichsen 1992). Only Bhutan has preserved the majority of its forests, which are crucial to the survival of many species extinct elsewhere in the Himalayas. Tigers, Asian Black Bears, Himalayan Tahr (*Hemitragus hemlahicus*), Red Pandas, Golden Leaf Monkeys (*Trachypithecus geei*), and Tibetan Macaques (*Macaca thibetana*) are among the many mammals endangered by the loss of Himalayan forests. The Woolly Flying Squirrel (*Eupetaurus cinereus*), the largest squirrel species in the world, has just been rediscovered in northern Pakistan after being thought extinct for 70 years (Walters 1995). Four feet from its nose to the end of its tail, this squirrel may be able to glide distances of up to 1,000 feet (Walters 1995). Peter Zahler, a Cornell University zoologist, traveled to Pakistan in 1994. In a remote valley where this squirrel was rumored to exist, a local villager, who found one in a mountain cave, supplied a live animal in a bag. Zahler studied it for a short time, photographed and measured it, and then hiked 3 hours up the

mountain and released the squirrel at its capture site (Walters 1995). This squirrel has been designated Endangered by the *1996 IUCN Red List Animals*. This exciting rediscovery is tempered by the threats from deforestation and overgrazing in its mountain habitat. Local people report that it is solitary and active throughout the year, climbing conifer trees to feed (Nowak 1999). The Woolly Flying Squirrel is not hunted, but the conifers on which it depends are being cut at a great rate, causing it to decline over the past decade (Nowak 1999). Its total population is estimated at fewer than 2,500 and falling as a result of habitat loss (Nowak 1999). (Photos of this squirrel appear in Nowak 1999.)

Eurasian Temperate Forests: Lost Forests of the Mediterranean and Europe

Forests of towering cedars, oaks, firs, pine and beech once blanketed the region surrounding the Mediterranean Sea. Wildlife abounded in these primeval forests. Some 8,000 years ago, forest cutting began (Mittermeier *et al.* 1999a). Livestock gradually replaced wildlife, stripping the vegetation. In 3,000 B.C., Phoenicians logged the great forests of Cedars of Lebanon (*Cedrus libani*) for ship and building construction to trade with Egyptians and other cultures (Mittermeier *et al.* 1999). These massive trees reach 130 feet in height and are among the most majestic and stately of all trees. On the island of Cyprus, an endemic cedar, the Cyprian Cedar (*Cedrus brevifolia*), covered the island. Centuries of tree cutting and livestock overgrazing have reduced this tree to a relict population. Other forests on the Mediterranean's eastern shores were felled for building and to clear land for agriculture and grazing. The Greeks cut their forests in spite of warnings by the philosopher Plato as early as 4,000 B.C. that water supplies and wildlife would disappear (Pontiff 1991). The country's climate grew dryer and its topsoil washed into the sea (Runnels 1995).

Italy's southern forests were cut in Roman times, but north of the Adriatic Ocean, large expanses of beech and oak forests remained intact until the 16th century when they became the raw material for ships and galleys that sailed the Mediterranean waging battles and trading. Enormous amounts of lumber were needed to build these ships. When an exact replica of a galley was reconstructed a few years ago, 650 mature trees were required: 50 beech trees were needed for oars, 300 pines and firs for planks and spars, and 300 mature oaks for hull timbers (Attenborough 1987). In 1571, Venetian fleets battled the Turkish fleet which had been attacking and looting their ships. The 500 vessels in the Venetian and Turkish fleets had required the felling of more than a quarter-million mature trees (Attenborough 1987). Soon thereafter, the building of Venetian galleys came to an end for lack of trees, and shipbuilding moved elsewhere in Europe where trees were still abundant (Attenborough 1987). A single forest resembling the original beech and evergreen forest remains intact near the Adriatic in the former Yugoslavia. Its beauty was filmed for the series, fiThe First Eden. The Mediterranean World and Manfl (see Video section, Regional, Mediterranean).

Hardwood forests covered much of Spain until the early 16th century when, by royal decree, it was decided that the economy of the country could be expanded by developing a Spanish monopoly on the breeding of Merino sheep for their valuable wool (Attenborough 1987). Sheep herds became larger and larger, and forests were cut to provide grazing land. Within decades, the forests that had covered central Spain were gone, and topsoil had eroded, leaving shrubland (Attenborough 1987). These forests have not regenerated. Some oak forests have survived in parts of Spain, but intact ecosystems with native ungulates and predators have disappeared. Livestock grazes in all but the most remote areas. The few remaining Gray Wolves, as well as the endemic Iberian Lynx (*Felis pardina*), are critically endangered due to loss of forests and persecution. As an indication of the degradation of habitat, many species of Spanish wildlife are threatened with extinction. Worldwide, about 11 percent of the world's birds are threatened with extinction (Collar *et al.* 1994), but 37 percent of Spain's birds are threatened, 53 percent of its mammals, 41 percent of its reptiles, and 45 percent of its amphibians (Peters and Lovejoy 1990).

Forests of pine, cedars and oaks blanketed the slopes of the Atlas Mountains of Algeria and Morocco prior to the

Roman conquest. Logging by the Romans and people in the intervening centuries has destroyed all but fragments of these forests. The Atlas Bear (*Ursus arctos crowtheri*) originally ranged in these forests but was gradually pushed toward extinction by loss of its forest habitat, hunting and capture. The last of these bears was killed in the late 19th century (Day 1981). The endemic Atlas Cedar (*Cedrus atlantica*) has wide girths and grows to heights of more than 125 feet. They are often covered in moss and lichens in the cool altitudes (color photo, see Mittermeier *et al.* 1999a). Unfortunately, they are fast being depleted by timber cutters in Morocco and Algeria (Mittermeier *et al.* 1999a). North Africa's forests have become fragmented by centuries of logging and heavy grazing by cattle, sheep, and goats. The native Wild Boar (*Sus scrofa*) have also been extremely destructive to the few forests that remain, endangering many birds (Collar and Stuart 1985).

Surprisingly, a bird species native to the Atlas Mountain forests remained unknown until 1975. The Algerian Nuthatch (*Sitta ledanti*), a small, buffy songbird with white eyebrows, was discovered in a national park on Mont Babor (Collar and Stuart 1985). Even in national parks in this region, however, livestock are permitted to graze, consuming young trees and other vegetation. After conservationists protested that this little bird's entire habitat would be eliminated if livestock were not excluded, sheep and goats-- but not cattle--were banned from the park in 1981. To prevent forest cutting by the local people, propane gas has been supplied to use as fuel for cooking and heat (Collar and Stuart 1985). The forest on Mont Babor consists of mixed Atlas oak, Atlas Cedar and the Algerian Fir (*Abies numidica*), a threatened species which grows only on this mountain (Walter and Gillett 1998). The Algerian Nuthatch uses cedars, oaks and, especially, the Algerian Fir for seeds and nesting (Harrap and Quinn 1995). The population of about 80 pairs of Algerian Nuthatches censused in Mont Babor National Park in the early 1980s remained constant, and in 1989, a second population of about 350 birds was discovered in a nearby oak forest within the Taza National Park (Collar *et al.* 1994). Even though the Taza has National Park status, conservation of the forest has been hindered by cattle grazing that prevents tree regeneration. Also, wood-cutting is allowed that removes potential nest sites, and fires are set, killing many types of animals (Harrap and Quinn 1995). These birds also survive in two small isolated tracts of unprotected, degenerating forest 30 kilometers away, but the total population probably does not exceed 1,000 birds (BI 2000).

Another rare animal, the Barbary Deer (*Cervus elaphus barbarus*), barely clings to life in the disappearing Algerian forests. It is now extinct in Morocco and survives only in a small forest of cork oak and pine on the border between Tunisia and Algeria. They number only a few hundred, including a captive population, and are declining each year. This subspecies of the European Red Deer is listed as Endangered onthe US Endangered Species Act.

Israel has reintroduced related subspecies of some wildlife that have become extinct, bringing in closely related races of gazelles, wild goats, wild asses and Ostriches. The forests, however, are unlikely to return. The vegetation surrounding the Mediterranean today is dominated by shrubland that can regenerate after frequent burning (Mittermeier *et al.* 1999a). Livestock in vast numbers consume tree saplings and pull plants out by the roots. Goats are able to climb low bushes and graze their tops. The soil structure is very loose and alkaline, and the nutrients have been leached out by thousands of years of cultivation, overgrazing and erosion. Only plants that survive in arid climates on poor soil, such as succulents, annuals and those that regenerate from roots, can grow here (Peters and Lovejoy 1990). In many areas, exotic species, such as American prickly pears and Australian eucalyptus, have taken over as a result of the impoverished soil. The remaining bits of forest in southeastern Spain, Morocco, Algeria, Syria and Israel are being cut for fuel at a rate of 14 percent per year (Peters and Lovejoy 1990). The net result of the widespread loss of forests in the Mediterranean is that only about 1 to 2 percent of pristine, original forest remained at the end of the 20th century, all in small fragments surrounded by farmed and developed land (Mittermeier *et al.* 1999a).

The transitions that brought about the present state of affairs occurred over many centuries. So gradual was the environmental deterioration that one generation of people was usually unaware of the ecological changes wrought by previous generations. Once the forests were lost, succeeding generations may have been unaware that they had ever existed. Whether any progress can be made in regenerating forests by bringing in topsoil and replanting in protected areas will depend on the concerns and will of the people of the Mediterranean, who number more than 300 million

(Peters and Lovejoy 1990).

North of the Mediterranean, vast forests covering most of Western Europe remained until a few hundred years ago. Deciduous and mixed pine forests were logged over the centuries near towns and cites, and the forests retreated, replaced by agriculture and grazing land. By the 18th century, 90 percent of the forests had disappeared. In Scandinavia, Germany, Austria and Switzerland, tree farms have taken the place of natural forests. Man-made hallmarks of civilization now cover northern Europe except for a few isolated pockets of original virgin forest. Along with these forests, went the Auroch (*Bos primagenius*), an immense wild cow that became extinct in the 17th century. The large predators, Gray Wolves, Lynx and Brown Bears, that preyed on deer, elk and European Bison (*Bison bonasus*) were persecuted to near extinction and remain very rare. The largest remnant of these once vast forests is Bialowieza, on the Polish-Belarus border. It harbors the last herd of free-ranging European Bison and a small number of Gray Wolves.

An organization to protect these wolves, The Association for Nature "Wolf" is also concerned about the cutting of the old-growth trees in Bialowieza Primitive Forest, of which only 22 percent is protected in Poland (Nowak and Myslajek 1999). The "Wolf" organization is working to stop logging and protect this forest for future generations by the creation of a transnational park with Belarus (Nowak and Myslajek 1999). As the top predator in this and other forests of Poland and other European countries, the Grey Wolf helps maintain the health of the forest and cull overpopulations of hoofed animals such as deer. *Wolfnet*, the bulletin published by The Association for Nature "Wolf," is helping to educate the public about this maligned animal, which is often killed on sight in Europe. The organization is also sponsoring studies of the estimated 500 wolves in Poland and training livestock owners in the use of guard dogs to protect sheep (Nowak and Myslajek 1999).

Eurasia's northern boreal forests, or taiga, are far more extensive than North America's, stretching 6,000 miles from the Atlantic coast of Norway east to the Sea of Okhotsk on the Pacific rim (Sparks 1992). The western section in Scandinavia is almost gone: more than 90 percent of the taiga in the Scandinavian peninsula has been replaced by tree farms, which support almost no wildlife (Walsh 1995). Norway has lost 100 percent of its natural forests, and Sweden and Finland nearly all of theirs (Walsh 1995). The result of this destruction has been a crash in forest biodiversity and declines in many forest species. Seventy•three species of birds are declining or vulnerable in this region, including the Siberian Jay (*Perisoreus infaustus*) and White•backed Woodpecker (*Dendrocopos leucotos*) (Walsh 1995). Sweden's tree farms have replaced more than 200 species of plants and animals, and 800 species are rare or declining, as reported in *Taiga News: Newsletter on Boreal Forests* in 1992. The same publication noted that 805 species are endangered from clearcutting old-growth forests in Finland, and conservation groups have formed to try to save them from corporate logging. The Russian portion of taiga forest, which makes up the majority of these forests, has been less damaged, but with the fall of the Soviet Union, forests are now open to international lumber companies. Much of this forest is so remote that it may never be logged, but millions of acres are likely to be leveled over the next century.

Temperate Rainforests of the Southern Hemisphere

South of the Equator, in widely separated areas, are remnants of forests with species of trees older than the dinosaurs. These temperate rainforests grow in southern Chile and Argentina and, far to the west, in New Zealand, eastern Australia and the islands of Norfolk and New Caledonia. They have been growing nearly undisturbed for more than 100 million years, and many species of animals native to them have ancient lineages as well. Giant beeches grow in southern South America as well as far away in southern New Zealand and Australia. All these trees once grew on the southern supercontinent, Gondwana, some 160 million years ago. New Zealand, Australia and South America were joined and these trees were part of vast primitive forests. The continent gradually broke apart. Many species of trees survived on these new continents and islands as long as they could adapt to the new climates of the

different latitudes and longitudes, where they were pushed by continental drift through movements of the Earth's tectonic plates. In spite of eons of dramatic changes on Earth, geological and climatic, large fragments of these ancient forests have survived to the 21st century, only to face possible extinction. The wildlife now inhabiting them is predominated by more recently evolved species which coexist with species whose ancestors inhabited Gondwana. These fragile and unique ecosystems have undergone radical changes over the past few centuries, and many have been logged and cleared, with serious consequences for the native wild animals and plants.

South America

Only a century ago, South America's primitive forests blanketed the entire region from the southern tip of the continent north half the length of Chile's coast and eastward into Argentina's Patagonia. Beech trees of the genus *Nothofagus* covered most of the region, mixed with evergreen and various deciduous trees. Once extending more than 35 million acres, these forests comprised the largest stands of pristine temperate rainforest in the world (Nash 1994). *Nothofagus* beeches are among the most ancient species of trees and have been on Earth more than 150 million years. Soon after their arrival in the 16th century, European settlers began logging these forests, but not until the 20th century did widespread clearance begin. During the 1940s and 1950s, some 13,000 square miles, or 8.3 million acres, of these beech forests were cleared and burned for cattle ranching. Commercial logging continued, subsidized by the Chilean government, which spent comparatively little on forest conservation (Sims 1995). These beautiful forests have been cut mainly for wood chipping factories that produce paper pulp for export to Japan. Powerful commercial lobbyists have opposed legislation to protect the portions of these forests that remain, enabling logging companies to continue clearcutting, pushing some species to the brink of extinction. Once logged, the land is replanted with plantations of eucalyptus or pine, or turned into pastureland for livestock. The *1997 IUCN Red List Plants* lists four species of *Nothofagus* native to Chile and Argentina as vulnerable, indicating a decline toward Endangered status that, if not reversed, will result in their extinction (Walter and Gillett 1998).

Not all Chilean government officials are proponents of the logging. Carlos Ritter, head of the technical department for the National Forest Corporation, a government entity, complained: "Japan has fomented the cutting of our native forests, but they try not to assume responsibility. They say they are only buying the wood. But they have created so much demand the peasant farmer cannot resist cutting his forest" (Nash 1994). During the 1990s, an American logging firm, the Trillium Company, purchased 632,000 acres, or 987 square miles, of ancient forest in the southernmost region, Tierra del Fuego (Sims 1995). The Chilean government overruled opposition and gave permission to the company to begin logging in mid-1996.

An American conservationist, Douglas Tompkins, has preserved some of these forests. He purchased 741,000 acres in the southern province of Palena with more than $12 million from his clothing chain, Esprit. The cost of these beautiful forests, at $17 per acre, was miniscule in comparison to the cost of preserving temperate rainforests in the United States. Save•the•Redwoods League, an American conservation organization founded in 1918, recently celebrated its 75th anniversary, having spent $73 million to save 260,000 acres (about one•third of Tompkins™ acquisitions in Chile) of Coastal Redwoods at an average price of $280 per acre (National Geographic Society 1993). Most of the acreage of American old-growth redwoods that has been saved was purchased decades ago, and today it is worth hundreds of thousands of dollars per acre. The timber saved by the Save-the-Redwoods League is worth more than $5 billion (National Geographic Society 1993).

Tompkins' land includes South America's largest block of virgin temperate rainforest, protecting 78 percent of the remaining old-growth rainforest in Chile, including the country's largest remaining virgin stands of Chilean Larch or Alerce (*Fitzroya cuppressoides*) (Bowermaster 1995). This endemic and ancient tree grows to heights rivaling North American Coast Redwoods, with girths nearly as great as Sequoias (*Sequoia dendron*) (Dorst 1967, Walter and Gillett 1998). These majestic trees can live up to 4,000 years and take 500 years to reach commercial size. Extremely slow

to reproduce, Alerces do not produce seed until 200 years of age. Like redwoods, they are highly coveted for their lumber and have been cut with little regard to conservation. Highly endangered in Argentina and Chile (Walter and Gillett 1998), few groves of these trees remain, and although officially protected, they are sometimes illegally cut for the international timber market.

Tomkins came under attack by Chilean politicians and leaders of the Catholic Church who questioned his motives in purchasing such a large area and objected to his organization, the Foundation for Deep Ecology, for its statements about the importance of birth control to prevent human overpopulation (Sims 1995). Others falsely accused him of razing forests, setting up a nuclear dump, promoting abortion and even importing Israeli commandos. Many objected to private ownership of extensive areas of land by foreigners or disliked the idea of large-scale land preservation, but a Chilean conservation organization, the National Committee for the Defense of Fauna and Flora, rallied to his defense. After much contention, the Government of Chile accepted Tompkins' gift of 677,000 acres as a park in July 1997 (Grove 1999). It is known as Pumalin National Park and is considered one of the most ecologically important national parks in South America.

In an ominous note, part of the agreement with the Chilean government allowed access to the park by mining companies. The forest will not be logged, and there are plans for tourist accommodations and trails for hiking. This land is spectacularly beautiful, with glacial lakes and waterfalls, bisected by pristine rivers, its ancient forests teeming with wildlife. Covering the entire width of Chile, it borders a magnificent coastline with abundant marine mammals and sea birds. If preserved with care, the park will prevent the extinction of Chilean Larch and at least a portion of the magnificent southern beech forests which have been destroyed elsewhere. Ecotourism is being developed in the park area on a very small scale, with rustic accommodations, and tours from the United States and elsewhere are now visiting the park regularly. Not far to the north, the Parque Nacional Huerquehue preserves some of the magnificent scenery of this region. Known as the Lake District, portions of old-growth rainforest are protected in a landscape of crystalline lakes, waterfalls and churning rivers.

Another tree that survives from the Jurassic, the Monkey Puzzle Tree (*Araucaria imbricata*), has a somewhat larger range in South America. It is a member of a family of primitive conifers, the Araucaria, that grew on Gondwana. Monkey Puzzle Trees are being logged for timber and displaced by development, cattle ranches and mines. Named for their dense and interwoven crowns said to puzzle monkeys climbing them, the wide, unbranched trunk is covered in leathery bark in a knobby, diamond-shaped pattern. The nuts produced by these trees have been prized by the native Malpuche people for thousands of years. Malpuche means "People of the Monkey Puzzle Tree," and traditionally they did not overexploit these trees. Commercial exploitation of the nuts in local markets is threatening the species by leaving too few seeds for regeneration. Extracts from the Monkey Puzzle Trees have shown promise as a birth control drug, a traditional use by native peoples.

Like the Alerce, Monkey Puzzle Trees live to be very old, at least 1,300 years, and trees of the Araucaria family are considered the progenitor of all pines (Grove 1999). (See photographs in Grove 1999, and Dorst 1967.) When the Discovery Channel-BBC producers of the documentary film, fiWalking With Dinosaurs,fl searched for living landscapes in which to place their animated dinosaur models, an open forest of Araucaria trees in Chile was selected as an authentic backdrop, having changed little since dinosaurs fed on their crowns. The book based on this film has photographs of Araucaria forests from the movie (Haines 1999). Thirty-eight species of Araucaria survive, distributed in South America, New Zealand, Fiji, New Caledonia, Australia and Norfolk Island north to Malaysia. More than three-fourths of these, 30 species, are threatened with extinction, according to the *1997 IUCN Red List Plants* (Walter and Gillett 1998).

Another family of trees dating back to Gondwana, the podocarps, are also extremely primitive evergreens. Podocarps often have straight, unbranched trunks and clumps of dense needles near the trunk. Like the Araucaria, many of the species in the family are in decline: of 125 species worldwide, 70 are threatened (Walter and Gillett 1998). Two of these inhabit the southern rainforests of Chile and Argentina, and others survive in more tropical climates in Venezuela, Bolivia and Brazil, Madagascar, New Caledonia, Fiji, New Guinea and Malaysia. Australia

and New Zealand have more temperate climates and many native podocarps.

A threatened bird native to the old-growth forests of Chile and southern Argentina is the Slender-billed Parakeet (*Enicognathus leptorhynchus*), one of the few members of the parrot family that can survive cold climates. It has undergone steep declines in recent years as a result of forest clearance (Forshaw 1989). At least 22 bird species are restricted to Chilean *Nothofagus* forests, making this region a center of endemism (Cracraft 1985).

The most endangered denizen of southern rainforests may be the South Andean Huemul (*Hippocamelus bisulcus*), a short•legged, stocky deer that once lived throughout this habitat in Chile and Argentina. Driven from most of its haunts by the introduction of European deer, cattle ranching, logging and hunting, they now survive only in the extreme south of Chile, in tundra•like terrain with elfin woodlands. Low, gnarled trees are whipped by the strong ocean winds from Antarctic regions (Dorst 1967). No more than 1,300 South Andean Huemul are thought to remain (Nowak 1999), and a campaign has been launched to save these deer (Stutzin 1995). The National Committee for the Defense of Fauna and Flora and the Frankfurt Zoological Society are researching their status and raising money to purchase sufficient habitat for their survival (Stutzin 1995). Two reserves protect about 100 Huemul, but as the target of meat poachers throughout their range, they are found only in inaccessible areas. Researchers studying these deer, which had never had contact with humans, found them completely unafraid, grazing and bedding down within feet of their tents. This tameness makes them especially vulnerable to poachers.

Without immediate habitat protection and guarding of the remaining deer, the Huemul may not last long. Their status has declined even in national parks within the past few years. Alejandro Frid, a biologist who found these deer living in pristine habitat along a fjord in extreme southern Chile in a 1990 study, returned in 1995 to find near-disaster. Cattle had been set free in the Bernardo O'Higgins National Park, displacing the Huemul from their prime grassland habitat and forcing them into the sparse vegetation of the uplands (Frid 1997). He was told by a local ex-poacher that illegal hunting by local fishermen still occurred, and the lowland habitat was so trampled by the cattle that it was covered in muddy pits (Frid 1997). Ironically, the owners of the cattle did not eat beef but were adopting European cultural traditions, and since this harsh region did not provide good habitat, the cattle were not in good condition (Frid 1997). Conservationists are working to have the cattle removed from the national park, and international organizations are working to protect remnant populations of these deer. On the Straits of Magellan, where other South Andean Huemuls survive, commercial logging corporations are clearing forests (Frid 1997). The introduced Elk (*Cervus elaphus*) competes for habitat, and many Huemul are killed in attacks by domestic dogs (Nowak 1999). The South Andean Huemul and its close relative the North Andean Huemul (*Hippocamelus antisensis*) are both listed as Endangered on the US Endangered Species Act. This listing may not prevent their extinction, however.

The world's smallest deer, the Southern Pudu (*Pudu puda*), also inhabits southern temperate rainforests. This dog-sized deer is short-legged, with thick, buffy, reddish-brown fur and small, spike-like antlers. It is so diminutive, weighing only 5.8 to 13.4 kilos (Nowak 1999), that people have captured them as pets, which has contributed to their rarity. Its range within Chile was once far more extensive (Nowak 1999). The major threat to this species and its close relative, the Northern Pudu (*Pudu mephistophiles*) of the Andes of Peru through Colombia, is forest destruction. *Pudu puda* is listed as endangered on the US Endangered Species Act and on Appendix I of CITES, banning commercial trade, but hunting still threatens it.*

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*Many trees of the southern beech forest, the South Andean Huemul and Pudu deer appeared in the 1997 film, fiChile, Land of Extremesfl (see Video, Central and South America section); the trees were photographed in *Living Planet, Preserving Edens of the Earth* (Grove 1999).

New Zealand

New Zealand was formed some 80 million years ago when it broke off from the tropical southern continent, Gondwana (Molloy 1994). The land mass moved away with resident pterosaurs, sauropod and carnosaur dinosaurs, along with primitive frogs, lizards, land snails, spiders and other insects and invertebrates. It is also possible that the ancestors of the flightless moas and kiwis were present on Gondwana (Heather and Robertson 1997).

Unlike South America, New Zealand remained uninhabited by humans until a thousand years ago, allowing an extraordinary fauna and flora to evolve. Giant trees of many types, some almost as massive as sequoias and others rivaling American Coast Redwood in height, thrived in primeval rainforests and swamps. The dinosaurs died off 65 million years ago simultaneous with their extinction elsewhere in the world. Over the eons, as the land moved southward, the climate cooled. Many tropical species, unable to adapt, died out, while others coexisted with immigrant species of plants, birds and insects that arrived by wind or ocean current. Geological and climatic events--from earthquakes and mountain uplifts caused by movements in the Earth's plates, to the weathering of wind, sun and rain--produced great changes in the topography over the millennia. The original land mass split into two main islands and many satellite islands, and snow-capped mountains rose on the southern island. Ice Age glaciations occurred during the Pleistocene between 2.4 million years and 10,000 years ago (Molloy 1994). These cold periods did not, however, eliminate the majority of ancient plant or animal species, another proof of their amazing adaptability.

When the Polynesian Maori people arrived about 1,000 A.D., temperate rainforests with understories of giant tree ferns grew throughout the island's swamps, lowlands and highlands, over 80 percent of the land. The Maori must have been stunned to see thousands of flightless birds of various sizes roaming the island. The moas had evolved from a single ancestor into some 11 species which grazed in herds or in small groups. Following the extinctions of the dinosaurs, moas evolved in a wide range of species able to browse vegetation in forest, shrubland and grassland habitats (Molloy 1994). The native plants developed thorns and other means of defense against the moas. These plant adaptations persist today, long after the disappearance of the moas, remnants of a bizarre and fascinating ecosystem. These emu-like birds ranged from chicken-sized to a species 10 feet or more in height, the tallest bird that ever lived. With heads disproportionately small and necks long and gangly, these down-covered birds walked about on thick, scaly legs. Also resident on the islands was a massive eagle, weighing up to 29 pounds (Molloy 1994). This giant bird of prey was the largest eagle to have ever lived on Earth and may have preyed on moas or soared about in search of moa carrion.

On the southern island, penguins lived on rocky coasts and in wet coastal rainforests; one species was a giant, standing more than 5 feet tall (Molloy 1994). No mammals other than bats were native. Lizards called tuataras, older than dinosaurs, lived in many habitats on the islands. Primitive and unusual frogs of types long extinct elsewhere were abundant, especially in mossy rainforests. Huge, cricket-like wetas, insects virtually unchanged for 200 million years, had evolved into 70 species. Compared to grasshoppers, wetas have heavy bodies, weighing as much as 2.5 ounces. Scurrying about at night, their diet and behavior are rodent-like. They are considered by zoologists to be among the most interesting animals on the islands (Molloy 1994).

The forests were dominated by trees very little changed since the age of the dinosaurs. Three major groups of trees, all evergreens, dominated New Zealand's forests, survivors of the Cretaceous Era 135 million years ago: araucaria, podocarps and southern beeches. All had close relatives in South America and other parts of the world.

A single species of the Araucaria family, to which the South American Monkey Puzzle Tree belongs, dominated forests on North Island. The enormous Kauri (*Agathis australis*) has a massive, wide trunk that rises to great heights

before branching in a wide canopy. Its gray, grainy bark forms deep, vertical ridges that curve upward, wrapping around the tree as it rises hundreds of feet into the air. Verdant tree ferns, with large, short trunks, and primitive club mosses form an understory beneath them.

Seventeen species of podocarp trees survive in New Zealand, some of which reach great heights. New Zealand's tallest tree is the Kahikatea (*Dacrycarpus dacrydioides*), or New Zealand Cedar, a type of podocarp which is nearly as tall as Coast Redwoods but with a slimmer trunk, often covered in epiphytic plants (Molloy 1994). Podocarp forests were once very widespread throughout both North and South Islands, each species in a slightly different habitat (Molloy 1994). At the other extreme is the world's smallest conifer, the ankle-high Pygmy Pine (*Lepidothamnus laxifolius*), a podocarp growing at high altitudes in a beautiful area known as the Southern Alps on South Island (Molloy 1994). Another podocarp type, the Celery Pines (*Phyllocladus spp*), are small trees whose leaves are actually flattened stems. One podocarp, *Halocarpus kirkii*, is listed as Threatened by the International Union for the Conservation of Nature (IUCN) (Walter and Gillett 1998), and all have declined dramatically in range.

Southern beeches of *Nothofagus*, the same genus as those in South America, once blanketed South Island in dense, canopied forests, often without an understory of plants other than low ferns (Molloy 1994). Today some forests remain, growing in association with broadleafed trees and hardwoods that arrived in New Zealand at a more recent time (Molloy 1994).

Some extremely primitive plants have also survived in New Zealand. The largest moss in the world (*Dawsonia superba*), giant liverworts, clubmosses and horsetails are among these (Molloy 1994). *Tmesipteris*, an epiphyte, is a relict of the earliest vascular plants, which evolved some 400 million years ago. This rootless plant clings to the branches of trees and hangs in vine-like, leafy strings. New Zealand's forest floor plants, a micro-world of species, most of which are less than an inch high, are beautifully photographed and described in *The Forest Carpet* by Bill and Nancy Malcolm (1989), a book devoted to New Zealand's mosses and related plants.

Other survivors from Gondwana include an extremely ancient family of spiders, Archaeidae. First described from a specimen frozen in amber several million years old, seven species have been found on Madagascar, also a part of Gondwana: one in South Africa, three in Australia, five in New Zealand and one at the tip of South America (Preston-Mafham 1991). The Archaeidae spiders have strange, grotesquely shaped bodies, visible only through a microscope since they are only 0.14 inches long; they live among leaf litter on the ground (Preston-Mafham 1991).

The beauty and primitive auras of many of the Kauri, beech, podocarp forests and pristine forest swamps evoke a "bygone era when dinosaurs still roamed the Earth" (Molloy 1994).* Beech and podocarpus forests cover South Island's Fiordland, a region along the southeastern coast resembling Norway's fiords, with inlets penetrating deep inland, lined by misty forests. The trees are buffeted by fierce winds from the west that bring rainfall of up to 20 feet a year. In this rugged wilderness, mosses and huge tree ferns thrive in the dampness.

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*Many of the primitive landscapes that survive in New Zealand were captured in Gerald Cubitt's photos in *Wild New Zealand,* accompanied by natural history information in the text by Les Molloy (1994). Also, two films, fiLand of the Kiwifl and fiMountains of Water,fl described in the Video section, display these vistas.

The moas, which must have been very tame and unafraid, were hunted by the Maoris, who lived on their meat and eggs for centuries. The last of the moas, all smaller species, are said by some authorities to have survived until the 18th and 19th centuries (Greenway 1967), although this is disputed by others who assert that the moas were killed off well before the 15th century (BI 2000). Some Europeans claimed to have seen living moas, but no account was ever confirmed. Millions of their bones and eggs, and a few examples of skin, are all that now remain of these birds. The giant penguin, giant eagle and many flightless birds were also wiped out, apparently by hunting. European settlers eliminated many more species when they cleared forests and imported animals, such as dogs, cats, the weasel-like

stoat that preyed on native animals, and livestock that eliminated their habitats. Apart from the moas, nine birds, one reptile and one mammal are known to have become extinct in New Zealand since 1500. One of the birds, a beautiful forest songbird, the Huia (*Heteralocha acutirostris*), was truly unique: the male and female had different sized and shaped bills. Hunted for its plumes, and with its habitat destroyed, the Huia was last seen in the late 19th century. Others, including a flightless owl; a quail; two wrens, one of which was the only known flightless songbird; a bittern; a thrush; a storm-petrel; a flightless rail; and another songbird became extinct. A gecko and a native bat also disappeared (see Appendix for a chronological list of these species).

Although the Maoris cut and burned portions of the Kauri forests, not until the Europeans arrived in the 18th century did clearcut logging begin. Captain James Cook, the first European to visit New Zealand, noted some very tall trees that were probably Kauris while reconnoitering for lumber on his visit to New Zealand on November 21, 1769: "I judged that there was 356 solid feet of timber in this tree clear of branches." Millions of these great trees were felled for lumber or to clear land, leaving only fragments of the original forests. On the Coromandel Peninsula on North Island, isolated patches of mature Kauri forest are protected in several sanctuaries where old tramways, constructed to remove the logs, still scar the landscape (Molloy 1994).

Overall, approximately 75 percent of native forests in New Zealand have been cleared for agriculture and grazing land for 60 million sheep and other livestock. Fortunately, the Government of New Zealand has set aside many large parks and reserves to preserve landscapes, forests, endemic plants and animals. Thirty percent of the islands are protected, one of the highest rates of preservation in the world. In the majority of western Europe, for example, less than 5 percent of the land is protected, and villages and residences are allowed in many national parks. Not all New Zealand's ancient forests are safe from logging, however. A controlling interest in one of the last sizeable expanses of forest, 193,000 acres on the northern end of South Island owned by Fletcher Challenge Ltd., a logging company, was sold in 1997 to the US lumber company, Weyerhauser.

Many native animals of New Zealand's forests have been pushed to the edge of extinction by a combination of loss of habitat and the introduction of exotic species. Even the weta insects are in decline. Nine weta species are listed on the *1996 IUCN Red List Animals* (Baillie and Groombridge 1996). All four species of kiwis in New Zealand are rapidly approaching extinction, listed as Vulnerable or Endangered by *Threatened Birds of the World* (BI 2000). Authorities now recognize four, rather than three kinds of kiwi, and one, the Brown Kiwi (*Apteryx mantelli*), is endangered, its population having declined 90 percent since 1900 (BI 2000). Among the most ancient of bird species and possessing many unique physical and behavioral characteristics, their loss would represent as important a biological tragedy as the extinction of the moas. They have been placed in their own family, Apterygidae, an indication of their uniqueness. These flightless birds, which weigh from about 2 to 10 pounds, have small, stunted wings with claws on the end that are hidden beneath a cloak of shaggy, brown, hair-like plumage, giving them a mammalian appearance. Their long, pointed, ivory-colored bills are used to probe the leaf litter on the forest floor for earthworms and other invertebrates at night, and they can be heard snuffling as they forage. They have short, strong legs, and long, sharp claws on their toes, used for digging and fighting (Heather and Robertson 1997). Their food supply is ample: 200 species of earthworms live in New Zealand, with the largest species measuring an amazing 40 inches in length and 4 inches in diameter (Molloy 1994).

At the end of the kiwis' bills are nasal openings for their highly developed sense of smell, which aid them in detecting their prey. An acute sense of smell is a highly unusual trait in a bird. Kiwis also have sharp hearing but poor eyesight. Such characteristics are more common in mammals than birds (Hoyo *et al.,* 1992). Kiwis possess other mammal-like traits, such as two functionally alternating ovaries rather than one in the female (Feduccia 1996). In an interesting evolutionary phenomenon, where land mammals are absent, animals totally unrelated to them often develop mammal-like traits. Kiwis mate for life and live in large burrows. The single egg laid by the female is enormous in proportion to her size, weighing 20 to 25 percent of her weight. It is the largest egg, proportionally, of any bird and four times the size that would be expected for a bird her size (Hoyo *et al.* 1992). By comparison, a human mother weighing 125 pounds would have to bear a 25- to 30-pound baby. The hatching process is long and arduous, taking two to three days from the time the chick begins to break out; because the chick lacks an egg tooth, it

must kick its way out of the shell with its feet (Hoyo *et al.* 1992). Many chicks die during this process. When the chick emerges at last with damp feathers, its yolk sack is still connected and nourishes it for several days. A miniature version of its parents, it is able to follow them on their nocturnal feeding trips within a few days (Hoyo *et al.* 1992). (Rare footage of incubation and hatching of a kiwi in the wild can be seen in fiBirds of Paradox.fl See Video section F, Birds.)

Kiwis are totally unable to protect themselves against predators, such as dogs, cats, stoats and introduced Australian Brush-tailed Possums (*Trichosurus vulpecula*), who kill them or prey on their eggs (BI 2000). At least 94 percent of kiwis die before adulthood as a result of this predation (BI 2000). The possums also destroy rainforest vegetation by browsing on canopy leaves, epiphytic and ground plants; they have exterminated a native mistletoe (Molloy 1994). Non-indigenous animals have effectively eliminated kiwis from all but a few remote parts of their original ranges. At least one reserve, the 290-square-mile Coromandel Forest Park, has erected a fence within the Kauri forest to keep out possums, protecting kiwis and other native birds (Molloy 1994). Elsewhere, kiwis are being killed by predators; official government protection since 1908 has not stopped their continued decline. Feral dogs killed 500 Brown Kiwis in a population of 900 in less than two months in the early 1990s (Hoyo *et al.* 1992). Another cause of mortality has been steel-jaw leghold traps and poison set out to capture Brush-tailed Possums, although recently the use of traps has been regulated to prohibit any possible capture of kiwis (Hoyo *et al.* 1992). Dependence on humid rainforest habitat has also been a major factor in their disappearance, as this habitat has been destroyed by logging, fire and agriculture (Hoyo *et al.* 1992). Many kiwis are burned to death in the intentionally set fires that follow logging operations, as their shallow burrows do not protect them from the smoke, heat and flames. Often they are afield when fires are set and die in the fires. Those not killed lose their habitat when the humus and leaf litter essential for their feeding is consumed in the fires.

The Little Spotted Kiwi (*Apteryx ownii*) is the smallest and rarest kiwi, numbering only about 1,100 birds (BI 2000). A population of about 950 birds inhabits the 20-square-kilometer Kapiti Island off the southwest coast of North Island (Collar *et al.* 1994), where it was introduced from the mainland. Another introduced population on Tiritiri Matangi Island, a sanctuary of 543 acres off the northern coast of North Island, has adapted well (Molloy 1994). At one time, this kiwi was found throughout the main islands (Hoyo *et al.* 1992). In the summer of 2000, Little Spotted Kiwis were returned to a reserve on the mainland, a step toward their recovery. The Great Spotted Kiwi (*Apteryx haastii*), the largest species, is confined to forests in extreme northwestern South Island in the southern Alps (Heather and Robertson 1997). Although its habitat here is protected, its numbers are still declining from predation (Collar *et al.* 1994). At present, no Great Spotted Kiwis are living on a predator-free out-island (Heather and Robertson 1997), and only one small population is protected by controlling predators (BI 2000).

Another highly endangered bird, and a species almost as bizarre as the kiwi, is the Kakapo or Owl Parrot (*Strigops habroptilus*). The world's heaviest parrot, it weighs up to 3.5 kilograms and is the only living flightless member of the parrot family. It is also one of the rarest birds in the world. Once native to all but the highest mountain altitudes on North, South and Stewart Islands, Kakapos probably numbered in the tens of thousands (Collar *et al.* 1994, Forshaw 1989). They may have flown to the islands at a very early date, long before the land split into North and South Islands, and gradually lost their ability to fly. These 2-foot-long parrots have dull green plumage, mottled with brown, that blends into the vegetation of their rainforest habitat. Known as the Owl Parrot because of large eye discs and nocturnal habits, the Kakapo has another distinction in being the only member of the parrot family to gather in male groups near a bare area where "lek" displays are performed for females during breeding season. Males call females to the lek with loud, low-frequency, booming sounds emanating from their thoracic air sacs. These calls are audible to humans from as far as 3 miles away (Molloy 1994). They perform these booming calls for six to eight hours a night throughout the three- to five-month breeding season, which takes place only every three to five years under normal conditions (Heather and Robertson 1997). Very placid and slow-moving, they are unable to defend themselves against the rats, cats, stoats and dogs that Europeans brought to the main islands.

The range of the Kakapo began shrinking with the arrival of Maoris and their domestic animals, but in 1800 they were still common in central North Island and parts of South Island where their habitats had not been destroyed

(Heather and Robertson 1997). The European Stoat, introduced to the islands in the 1880s, proved an efficient predator of these parrots, eliminating them entirely from North Island and all but remote parts of South Island. In 1970, a survey revealed that only 18 Kakapos remained--all males--in Fiordland, South Island, and these last birds were gone by the early 1990s (Heather and Robertson 1997).

Fortunately, a previously unknown population of 100 birds was discovered in 1977 on Stewart Island, a fairly large island due south of South Island, but these birds were under attack from feral cats (Heather and Robertson 1997). After a decade of decline, all the remaining 61 Kakapos were transferred from Stewart Island by the New Zealand wildlife department to predator-free islets located off North and South Islands (Heather and Robertson 1997). In 1997, a lone female was discovered on Stewart Island and was removed (BI 2000). This rendered the species extinct throughout its original range. Unfortunately, many of the parrots starved to death in their new environments because these islets lacked sufficient food. Their natural diet of fruits, berries, nuts, fern fronds, roots, tubers, moss and fungi was abundant in the temperate rainforests and tussock grasslands of the main islands. A 1983 BBC documentary, fiBirds of Paradoxfl (see Video section), filmed a Kakapo chick being fed by its mother, who walked over steep terrain 3 miles each night to obtain seeds and other food for her offspring. Kakapos can live for as long as 70 years, and this longevity has prevented their extinction, since many years pass without any successful breeding. New Zealand wildlife officials finally provided supplemental feeding, which immediately resulted in the first surviving chicks in a decade in 1991. A population of 62 birds survived in 1999, of which 26 were females and 36 males, including six chicks (WC 2000). Although their numbers are slowly growing, many of the males appear to be sterile, and others have been filmed calling alone, rather than in male groups; some seem to be calling in vain, with no females responding (Hynum 1999). An Internet website has been established to monitor these extraordinary birds: www.kakapo.net.

Many other native songbirds, shorebirds, reptiles and amphibians are threatened in New Zealand, and some survive only on offshore islets where predators are absent or have been eliminated. New Zealand has had success in eliminating cats and possums from several sizeable islands off the main islands, but on North and South Islands, rats, cats and stoats, as well as European deer and goats, are uncontrolled (Molloy 1994). Some 70 million Brush-tailed Possums live throughout both islands, and they are now endangering forest birds by preying on eggs and chicks (Molloy 1994). Exotic plants have also invaded forests, smothering native plants and choking lakes (Molloy 1994). There is, however, a remarkable awareness in New Zealand of these conservation problems and its extraordinary natural heritage. Moreover, the government agencies dealing with wildlife and the environment, TV New Zealand Natural History (which makes superb wildlife films), and scientist-writers such as Les Molloy (1994) are educating the public about this natural legacy, much of which has endured for hundreds of millions of years. Contributions of funds and expertise from many nations and organizations might aid New Zealanders in their conservation work.

Australia

Australia's temperate rainforests are very similar to those in New Zealand, and fragments persist in portions of eastern and southeastern Australia. Relatives of the Kauri, the Nothofagus beeches, and podocarpus trees are native. An exciting botanical discovery was made in one of these forests in 1994. Named the Wollemia Tree (*Wollemia noblei*) after the national park where it was discovered, it is a member of the Araucaria family and somehow escaped attention until 1994. A species familiar to botanists through fossil records, it was thought to have become extinct 50 million years ago (Wilford 1994). A botanist noticed an unusual tree in Wollemi National Park in New South Wales, southeastern Australia and, when he investigated closely, found its fern-like leaves and other proof that it was indeed a living fossil (Wilford 1994). About 23 of these "living fossils" have been located in the park, the tallest towering 130 feet with a 10-foot girth and the species is being propagated by the Australian government. At a press conference soon after its discovery, Ken Hill, botanist at the Royal Botanic Gardens in Sydney, exhibited a fossil imprint of the Wollemia's fern-like leaves next to the living branches for news media, stating that it was one of the outstanding

biological discoveries of the century (Wilford 1994). Pictures of these trees were shown on television news programs around the world, an indication of the new appreciation being accorded such natural wonders. These massive pines have dense, waxy foliage and knobby, dark bark with strange-shaped branches growing from the trunk (Wilford 1994). They were found growing in a secluded area of little more than an acre, deep in the national park, where high humidity and moisture probably protected them from fire and provided ideal habitat (Wilford 1994). Had these priceless trees not survived in a national park, they might have been cut for firewood or commercial logs long ago. Wollemi National Park's protection was considered a great triumph for Australian conservationists. It contains the country's largest area of undisturbed forest--more than 486,400 hectares (1,201,894 acres) (Campbell 1989). The Colo River, the last unpolluted waterway in New South Wales, flows through the park. Other trees in this park include tall eucalyptus, which predominate; Snow Gums; Mallees; and pockets of rainforest in gullies (Campbell 1989).

Four species of Australian Podocarps are listed by the *1997 IUCN Red List Plants*. They range from Queensland's rainforests to temperate rainforests in New South Wales and Tasmania. Such forests, with their tall, evergreen trees and understories of tree ferns, are very rare today as a result of climatic change, a gradual drying of the continent and logging. Eucalyptus trees, which can withstand a dryer climate, gradually increased in range in Australia's temperate rainforests since they appeared in the Oligocene Epoch 35 million years ago (Vandenbeld 1988). They first colonized forest edges and flourished in open woodlands, then grew into entire forests growing from Queensland south to Tasmania, having radiated into 500 species (Vandenbeld 1988).

From New South Wales south to Tasmania, Nothofagus beech forests have been edged out by eucalyptus but remain in a few areas, a glimpse of the past. Mosses, ragworts, rotting logs, ferns and tree ferns carpet the forest floor, similar to those growing farther east in southern New Zealand (Vandenbeld 1988). European colonists logged these forests to clear the land for farms and grazing. The ancient eucalyptus, with their massive trunks, dwarfed the teams of oxen that dragged out the logs. This primeval forest is now almost gone. A 19th century artist, Isaac Whitehead, depicted a magnificent old-growth forest being logged in a dramatic painting showing trees that must have had circumferences of well over 50 feet. If not for the huge stumps that remain, one might have doubted that they actually existed (Vandenbeld 1988).

Forty percent of the country's forests have been cleared, including 75 percent of the rainforests in northern Queensland and 90 percent of both the dry mallee of the south and the eastern temperate woodlands (Parfit 2000). Logging had a devastating effect on the continent's woodland mammals who depended on the forests for survival. Of 144 marsupials inhabiting Australia 200 years ago, 21 are extinct, and a total of 88 Australian marsupials are listed in the *2000 IUCN Red List Species*. Many of these were forest species. Australia has had more mammals become extinct over the past few centuries than any other country in the world. The majority of forests in Australia did not revert to second-growth but became grazing land, plantations, agricultural fields, or tree farms of non-native pines for pulpwood (Vandenbeld 1988).

The eucalyptus forests that came to dominate many of Australia's woodlands are interspersed with savannah in the dryer north. In the south, they grow in dense, moist woodlands, with tree ferns and mosses as ground cover. Among the most characteristic trees of Australia, almost all the great old specimens are gone. Few Australians have ever seen a gigantic, 400-year-old eucalyptus tree, so massive that it takes 15 people to embrace its girth, but such trees were once common (Sharp 1995). It takes 200 to 300 years for a eucalyptus to form nesting holes that provide homes for possums, gliders, bats, snakes, birds, parrots and other creatures that were once prolific in Australia (Sharp 1995). The tallest trees in Australia, many eucalyptus stand more than 300 feet high (Attenborough 1995). In 1880, just before cutting it down, a surveyor measured a eucalyptus that stood 375 feet tall; another inspector around the same time told of a fallen trunk that was 435 feet long (Attenborough 1995). Had this been confirmed, it would have been the world record for the tallest tree ever measured (Attenborough 1995). Their straight, unlimbed trunks rise to great heights before branching. Settlers cut them for building materials and railroad ties, clearing vast areas and threatening many species. An astounding 175 species of the genus *Eucalyptus* are listed on the *1997 IUCN Red List Plants*.

In central Queensland, 5 billion eucalyptus trees were cut to create permanent grazing land for up to 2 million

cattle. Up to half of the trees in 100 million hectares in this Australian state have been cut (Arnold 1994). The last forests of Queensland are being cleared for livestock and agriculture at one of the highest rates of deforestation in the world, estimated at 840,000 acres a year (Parfit 2000).

Koalas (*Phascolarctus cinereus*), native to eastern Australia's eucalyptus forests, are entirely dependent on the leaves of these trees for their food. Most animals avoid eucalyptus because the leaves contain toxic oils, but Koalas have the ability to detoxify these oils, which also gives them a natural insect repellant (Berra 1998). They eat about 36 species of eucalyptus and obtain most of their moisture from dew and the leaves (Berra 1998). Forest clearing has had a disastrous effect on their populations. The last large population of Koalas in southeast Queensland was decimated by construction of an expressway, over vehement opposition from citizen groups (Arnold 1994). Likewise, in the state of Victoria in the southeast, Koalas have been reduced to a few remnant colonies as a result of hunting, development, tree cutting, highways, fires, droughts and predation by dogs and foxes. At least 4,000 Koalas are reported killed each year, and about 2,500 of these die after being struck by cars near urban areas (Berra 1998). They have also been victims of a variety of illnesses, including *Chlamydia*, which causes reproductive failure, pneumonia, blindness and other ailments (Berra 1998). They have declined so dramatically that in 2000 the species was listed as Threatened on the US Endangered Species Act.

Outside of protected areas, the last old-growth forests in New South Wales are being cut. The government accorded a giant multinational corporation, Boral, a contract to cut 500,000 tons of woodchips in the mid-1990s. (Arnold 1994). This logging will remove virtually every native forest not protected in national parks in northeast New South Wales, according to Sue Arnold, Coordinator of Australians for Animals (Arnold 1994).

Victoria still retains some old-growth forest, home to a host of rare animals. Old eucalyptus tower over tree ferns, sassafras, mountain pepper and mosses. In 1999 and 2000, loggers began cutting one of the last of these forests known as the Goolengook Forest (*EarthFirst! Journal* 2000). Aborigines have been able to stop logging in some traditional areas, including East Gippsland, Victoria, but the delicate and endangered native marsupials inhabiting most of these forests may not survive for long.

A strange mammal of Victoria's eucalyptus forests is Leadbeater's Possum (*Gymnobelideus leadbeateri*). Native to the Central Highlands, it lives in colonies in tall, old-growth eucalyptus trees (Strahan 1995). Thought extinct, this marsupial was rediscovered in 1961. With a tail almost twice the size of its body, huge black eyes and a stripe down its back, this possum looks like a cross between a squirrel and a skunk. Each night, it emerges from tree hollows to climb tall trees in search of insects. Forest clearing has destroyed much of its mountain forests (Nowak 1999). Only about 5,000 or fewer Leadbeater's Possums survive, and the species continues to decline as logging clears its habitat (Kennedy 1992). Its dependence on large trees, especially those 300 or more years old which have large tree holes for their nests, has made it very rare (Strahan 1995). Specializing in finding crickets, beetles, spiders and other arthropods beneath the shedding bark of eucalyptus and other trees, it may require, for an as yet unknown reason, a particular species of tree cricket which shelters under the bark of a certain type of eucalyptus (Strahan 1995). This possum also eats gum and tree sap. Less than 3 percent of its total range of 4,000 square kilometers is protected in nature reserves, and 75 percent is located in timber-production forests where tall, old trees are likely to be cut (Strahan 1995).

Tropical Forests

Tropical forests have, for the most part, evolved in stable environments over a period of millions of years, untouched by the recent Ice Ages. The oldest forests on Earth may be in Borneo where the same species of towering trees have been growing for 250 million years. Climates in tropical forests tend to be uniformly warm year-round, with half the year rainy, and the other half dryer but not without rain. Tropical trees generate enormous amounts of

moisture. In some parts of the world, the climate has changed over the ages, resulting in islands of forests surrounded by grassland or other habitats. Many scientists theorize that some forests, including the Amazon and African rainforests, went through such climatic changes during the Ice Ages (Collins 1990). Isolation might explain the evolution of a great number of endemic species in these regions, which today are continuous forest. These tropical forests are showcases of evolution.

Tropical forests vary greatly according to altitude, region and species of trees. Each has a different micro-climate, soil type, fauna and flora. They grow in tropical latitudes 30 degrees to the north and south of the Equator (Collins 1990). Among the many types of tropical forests are evergreen wet forests, deciduous dry forests, mountain cloud forests, and mixed lowland rainforests. In general, lowland rainforests are the most biologically diverse, as well as the most endangered. Covering only 7 percent of the Earth's surface, rainforests harbor half its species (Lean and Hinrichsen 1992). Biological research in tropical forests has consistently shown that this great diversity helps stabilize ecosystems and the very life support systems of the planet.

Some tropical forests have been characterized as "hotspots," having exceptionally high diversity of endemic species that are found nowhere else on Earth. All are threatened by deforestation. Two studies by ecologist Norman Myers in 1988 identified 10 highly endangered and biologically diverse tropical forest hotspots in the world; in 1990, he revised that number to 18 (Myers 1988, 1990; McNeely *et al.* 1990, Mittermeier *et al*. 1999a). Myers pointed out that the 10 hotspots named covered only 0.2 percent of the land surface of the world, but contained 27 percent of the plants and also a high percentage of endemic species. *Hotspots*, a book by Russell Mittermeier, President of Conservation International, and other biologists and ecologists, describes 15 tropical forest hotspots throughout the world among a total of 25 hotspots of all types of ecosystems. The high diversity in tropical forests is reflected in the fact that these hotspots covered 61 percent of the land area of all hotspots identified in the study. Many have lost 90 percent or more of their original forests and continue to decline. Originally, these extremely diverse tropical forests covered 10,635,513 square kilometers; at present, only 1,246,538 square kilometers remain, a loss of 86 percent (Mittermeier *et al.* 1999a). These tropical forest hotspots cover only 0.08 percent of Earth, but harbor 205,789 plant species and 21,903 vertebrate species other than fish (Mittermeier *et. al.* 1999a), a large percentage of the some 248,428 named vascular plants and 23,524 non-fish vertebrates (Wilson 1988). One can only wonder what diversity these areas had prior to their near-destruction. Such astounding facts should result in strong programs to preserve these regions, all of which are being degraded.

The tropical forest hotspots include the Caribbean, Central America, Brazil's Atlantic Rainforest, western Ecuador's Choco region, Andean tropical forests, Indo-Burma, the Philippines, Indonesia and Peninsular Malaysia, the Western Ghats of India, Madagascar, New Caledonia, Polynesia and Micronesia, Guinean Forests of West Africa, and mountains and coastal forests of Tanzania and Kenya (Mittermeier *et al.* 1999).

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The richest and most diverse hotspot on Earth is found in the tropical Andes, stretching from western Venezuela to Chile and Argentina (Mittermeier *et al.* 1999a). This area has innumerable isolated valleys, slopes, and peaks in many altitudes, all physical characteristics that contribute to the evolution of a great array of plants and animals. Covering 1,258,000 square kilometers, these forests are interspersed with alpine vegetation and grassland. Between 45,000 and 50,000 kinds of plants are found here, 20,000 of which are found nowhere else (Mittermeier *et al.* 1999a). Birdlife is prolific, with 1,666 species, 41 percent of which are endemic. Andean Cock-of-the-Rocks (*Rupicola peruviana*), threatened Toucan Barbets (*Semnornis ramphastinus*), the giant Andean Condor (*Vultur gryphus*), also a threatened species, and the greatest variety of hummingbirds in the world are resident (Mittermeier *et al.* 1999a). The critically endangered Yellow-tailed Woolly Monkey (*Lagothrix flavicauda*) is native to a few Peruvian cloud forests, and the Spectacled Bear (*Tremarctos ornatus*) and Mountain Tapir (*Tapirus pinchaque*) are other endangered species of the region. Deforestation has destroyed much of the region through slash-and-burn farming and extensive cultivation of opium poppies, which are controlled with herbicides that poison rivers and streams, suspected to cause declines in frogs and toads (Mittermeier *et al.* 1999a). Several national parks have been set aside, including the Madidi and Tambopota National Parks on the Peru-Bolivia border, covering some 2,225,000 hectares.

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The Atlantic forest of southeastern Brazil, another hotspot, has been reduced by 92 percent, yet it has been found to contain the greatest diversity of trees in the world: 476 species in a plot of only 2.5 acres, including 104 previously unknown tree species. By contrast, a plot of similar size in a North American temperate forest has only about 20 species of trees. A much larger plot, totaling 129 acres, in an old-growth forest in Malaysia's Lambir Hills National Park has an astounding 1,175 tree species (NGS 1997). This site is surrounded by farms, and nearby forests have been logged to the forest's boundaries. Both sites are tropical forest hotspots.

Africa's tropical forests once stretched in a wide band from Sierra Leone east through Zaire to Uganda and Kenya, and south to Angola. Of the original 3,620,000 square kilometers, less than half, or about 1,760,000 square kilometers, remained in the early 1990s (Martin 1991). The worst damage has occurred in West Africa where logging and clearance for plantations and villages have destroyed at least 85 percent of its rainforests (Collins 1990, Mittermeier *et al.* 1999a). Even the now-extensive forests of the Democratic Republic of the Congo and neighboring countries are being logged so rapidly that, outside reserves, they will have disappeared in 50 years, according to a 1997 study. A primate anthropologist, John F. Oates, researched the destruction of West African forests and the role played by international loan agencies such as the World Bank and the Ford Foundation. His book, *Myth and Reality in the Rain Forest. How Conservation Strategies Are Failing in West Africa* (Oates 1999), carefully documents the establishment of forest sanctuaries that did not protect forests and their wildlife, but encouraged logging, farming and bushmeat hunting. Almost no forest or sanctuary in West Africa is protected from logging, wildlife killing or capture, or other destruction. The rainforests stretching from Sierra Leone east to western Cameroon and the Gulf of Guinea islands of Equatorial Guinea comprise one of the world's most endangered hotspots for biological diversity (Mittermeier *et al.* 1999a). They covered 1,265,000 square kilometers a few hundred years ago, but have been reduced to only 182,348 square kilometers, or 14.4 percent of the original; of the remaining forests, only about 126,500 square kilometers are pristine forest, a scant 10 percent of the original (Mittermeier *et al*. 1999a). These forests are fragmented and largely unprotected. Some 9,000 species of plants exist in this region, of which 2,250 are endemic (Mittermeier *et al*. 1999a).

Some of the world's most fascinating and unusual wildlife species can be found here as well, including the world's largest frog, the threatened, 3.3 kilogram Goliath Frog (*Conraua goliath*), which inhabits mountain streams in Cameroon. The Western Chimpanzee (*Pan troglodytes verus*) of these forests is highly endangered by forest clearance and killing for the meat trade. Like the Chimpanzees of Kenya studied by Jane Goodall, they are tool-using, employing stones to crack open hard nuts on logs. They may be a completely different species of chimpanzee (Mittermeier *et al.* 1999a). Forest Elephants (*Loxodonta africana cyclotis*) are vital to forest ecosystems as seed dispersers and to open up forest glades for wildlife, such as the threatened White-breasted Guineafowl (*Agelastes meleagrides*) (Kingdon 1989). They also dig waterholes which provide a lifeline for a host of animals. Unfortunately, they are endangered as a result of deforestation and poaching. These forests also harbor many species of little forest antelope known as duikers, all less than 3 feet tall, which dart about the undergrowth in the Guinean forests. Sixteen of the 17 species are listed in the *2000 IUCN Red List Species*, declining from forest loss and intense hunting. The rarest is Jentink's Duiker (*Cephalophus jentinki*), of which only a few hundred remain. There are no individuals of this species in captivity, and no photo has ever been published of this little antelope (Martin 1991).

In spite of these extraordinary treasures, there are few national parks in the Guinean forests, and almost all remaining forests are being commercially logged. In Sierra Leone, the only protected area is Tiwai Island, a 12-square-kilometer, primate-rich area (Mittermeier *et al.* 1999a). The parks that have been set aside, such as the Tai National Park, an extremely important and biologically rich forest in the Ivory Coast, are under siege from illegal hunters, and farmers whittling away at the forest. Kakum National Park in Ghana has been aided by Conservation International in promoting ecotourism over the past six years; a new canopy walk and aid in tourist promotion helped attract 40,000 tourists in 1997 (Mittermeier *et al.* 1999a). Few of the existing preserves are large enough to preserve the diversity of wildlife and plants of the region. Unless dramatic action is taken, many extinctions will take place in the near future.

In Gabon, to the south of Cameroon, recent progress has been made in protecting a large block of forest in the

center of the country. Lope Reserve covers 1,900 square miles of Equatorial jungle coveted by loggers. An agreement signed in July 2000 between logging companies, the government and a variety of environmental organizations permanently prohibited logging in this sizeable area (Revkin 2000a). A compromise included the removal of 400 square miles of the reserve area with valuable Okoume Tree (*Aucoumea klaineana*) in order to add 200 square miles of extremely important habitat for primates, elephants and other wildlife (Revkin 2000a). Since 1957 when only a small percentage of Gabon's forests were open for logging, to the present when almost all the country is logged, wildlife has been driven from many areas by logging noise, roads that open up the forest to hunters and loss of habitat (Revkin 2000a). Dr. Lee J.T. White of the Wildlife Conservation Society has documented this phenomenon and has convinced the government to approve a country-wide forest inventory to identify other areas to protect for a network of national parks (Revkin 2000a).

The Lope Reserve, according to zoologist Jonathan Kingdon, does not include the Bee Forest, home to a very beautiful and rare primate, the Sun-tailed Guenon (*Cercopithecus solatus*), first classified and named in 1984. Dramatically patterned in dark gray with white facial markings and long reddish tails, these monkeys were photographed in the mid-1990s lying dead on tables at a market in Libreville, Gabon, offered for sale as meat (Bohan *et al.* 1996). Known only from this forest, this monkey is threatened by heavy logging in the forest by Isoroy, a French company acquired by Glunz Corporation of Germany (Bohan *et al.* 1996). The species is classified as Vulnerable in the *2000 IUCN Red List Species* (Hilton-Taylor 2000). Isoroy cuts about 140,000 cubic meters of logs per year from a 300,000-hectare (741,300-acre) concession in the Bee Forest, exporting logs to plywood factories in Europe (Bohan *et al.* 1996). The prime wood sought by the loggers is from the Okoume Tree, and a four-year study has found major damage being done to the forest in the process. On average, 8.5 trees were destroyed for every Okoume log harvested, and 49 percent of the forest canopy has been disrupted (Bohan *et al.* 1996).

The Sun-tailed Guenon is one of 26 species of guenons considered "refugia" species of African rainforests. During the Ice Ages, these forests shrank into islands, where many different primates evolved in isolation in these forest fragments. Each has brightly marked facial and body patterns (Kingdon 1989, 1997). These "masked monkeys," many of which were photographed in the spectacular PBS Nature film of that name, are often highly restricted in their ranges and considered threatened by the IUCN. Kingdon, who has studied these primates for decades, believes that they have brightly colored markings in order to see and identify one another in the dark forest foliage (Kingdon 1989).

A close relative of the Sun-tailed Guenon is the endangered Diana Monkey (*Cercopithecus roloway*), endemic to the Guinean region. This lovely primate's jet black face contrasts with its white chest and legs; its back is russet red and gray, and its long tail is black. Its fur seems to have been painted on, so silky and lustrous is its texture. The majority of Americans know little about this species and other endangered African monkeys. This was dramatically illustrated in the summer of 2000 when New York state authorities ordered the confiscation of a pet Diana Monkey kept by an immigrant family. This animal had been bought in a Long Island pet store in 1995, long after its listing on the US Endangered Species Act and New York's endangered species legislation, yet no one seemed to notice when it was offered for sale illegally. The new owners immediately had a veterinarian spay and remove the canine teeth from this female monkey, named her "Cookie" and dressed her in tutus as a family pet. They said they had no idea that she was an endangered species and refused to give her to the state, which planned to place her in the Detroit Zoo with a male of the species. She can never be part of a breeding program, however, and is a genetic loss to the species. Had the plight of these beautiful primates been better recognized and the species better known, this unfortunate incident would never have happened.

Another "masked monkey" native to Ghana and the Ivory Coast has recently been declared extinct, the first primate extinction in several centuries (Revkin 2000b). Known as Miss Waldron's Red Colobus (*Procolobus badius waldroni*), this monkey had colorful, reddish-brown legs and head, and charcoal body. Last seen in the 1970s, deforestation and hunting caused its extinction; thorough searches over seven years within its habitat proved fruitless (Revkin 2000b). Had it been protected in a forest reserve, this colorful monkey would have avoided extinction (Revkin 2000b). This extinction is likely to be followed in the near future by those of many other critically

endangered primates as a result of logging and hunting.

The deforestation of Central and West Africa also presents dangers for people. Many scientists warned that an inevitable consequence of opening up Africa's tropical rainforest through logging was the eruption of ebola virus and other diseases carried by native mammals. Such warnings went unheeded, and several outbreaks of the highly contagious and nearly always fatal ebola virus have occurred. Meat hunting of Chimpanzees in Gabon was a source of this virus, which has killed hundreds of people (French 1996).

The number of threatened vertebrates native to tropical forests of all types has grown astronomically in the past 20 years, concurrent with their widespread destruction. Indonesia, Brazil, Peru, Ecuador, India, Madagascar and Mexico are among the countries with the greatest number of endangered species, enormous diversity, and significant losses of tropical forest cover.

Among the hardest hit of tropical mammals are the primates. Ninety percent of all species inhabit tropical forests, and recent surveys have found that 204 species, or one-third of the world's 650 taxa (taxonomic listing including subspecies), are in high degrees of threat; 103 are critically endangered or endangered (Mittermeier *et al.* 1999b). In Southeast Asia, 90 percent of primates are either threatened or near-threatened, an amazingly high rate of endangerment. Primates are in rapid decline as a result of forest loss, killing for the pet trade, hunting for meat, and capture for zoos, the pet trade and research (Mittermeier *et al.* 1999b). The combination of all these factors has pushed some species so close to extinction that some primate species and subspecies have total world populations of fewer than 100 animals (Mittermeier *et al.* 1999).

Focus on Indonesia

Indonesia has the greatest biological diversity in Asia. A vast mosaic of 13,667 islands, Indonesia links two biogeographic regions known as the Sunda subregion, an area stretching from southern Burma and Thailand south to northern Indonesia and Borneo, with Oceania to the south and east. The political boundaries of Indonesia have little to do with ecosystems or ethnic cultures. The giant island of Borneo, for example, has been divided among several Asian countries. Indonesia claims the southern two•thirds, known as Kalimantan, while Malaysia rules two states in the north and west, Sabah and Sarawak, and the small independent country of Brunei lies on the northwestern coast. Likewise, New Guinea, whose Melanesian tribes have inhabited the island for thousands of years, has been divided between Indonesia, which rules with a strong military presence in the western half, Irian Jaya, and Papua New Guinea in the east, an independent nation. Politically, Indonesia has been in turmoil for decades, with a series of presidents who have grown rich on foreign aid and siphoning off profits from exploitation of timber, oil and minerals.

Focus on Indonesia: Page 1

The world's greatest variety of palm species grows in Indonesia along with 10,000 kinds of trees and 25,000 species of flowering plants (Collins *et al.* 1991). About 40 percent of its plants exist nowhere else, and its forests have a diversity of plants equaled only in Amazonia (Collins *et al.* 1991). One high-altitude forest on Borneo, Mount Kinabalu, has 70 species of oaks, and more than 100 grow on the island, along with 30 kinds of squirrels who feed on their acorns. Such trees are usually considered temperate forest species, but in these forests, which vary greatly in altitude and habitat type, an incredible variety grows. Two thousand species of orchids grow on Borneo (Mittermeier *et al.* 1999a). At high altitudes on Mount Kinabalu, the soggy ground is 90 percent covered in orchids, some with flowers as tiny as grains of rice (Lanting 2000).

Forests cover 85 percent of New Guinea (O'Neill 1996), the majority of which are humid, with very rich diversity in the lowlands. Above 750 meters, oaks and Araucaria trees related to those in South America's Atlantic Forest grow. Even higher, above 2,000 meters, tangles of bamboo and *Nothofagus* beech trees grow in great stands (Beehler *et al.* 1986). New Guinea's mountains rise above 4,200 meters, where alpine shrubbery and boggy grassland dominate. Mangrove forest fringes most coastal areas (Beehler *et al*. 1986).

Until the beginning of the 20th century, forests of many types covered most of Indonesia. The isolation of many of the islands from one another resulted in a radiation of evolution in all types of plants and animals. Many species of animals that had become extinct or rare on mainland Asia still thrived in Indonesia--rhinoceros, Asian Elephants, Tigers and Orangutans, for example. Other mammals, such as the extraordinary, long-nosed Proboscis Monkey (*Nasalis larvatus*), evolved among the mangrove swamps of Borneo. An unparalleled beauty and wealth of birds had evolved. Among these were birds-of-paradise, parrots, lories and cockatoos, colorful songbirds and hornbills. As the 21st century dawns, however, this diversity is in ruins, with many plants and animals close to extinction. The small original populations of many of the endemic species made them highly vulnerable to loss of habitat as the ancient trees were felled, and population growth consumed millions of acres for agriculture.

Of more than 1,500 species of birds native to the islands of Indonesia, or 17 percent of the world's avifauna, 430 are endemic to the country (Collins 1990). Indonesia has twice the number of breeding birds as North America in only one-fifth the land area. Many of these birds live on only one or two small islands. About 164 species are endemic to the Sunda subregion alone. The great loss of forest and other types of habitats in Indonesia is perhaps the most important cause threatening 319 species of native birds, of which 114 are extremely threatened (BI 2000). This is the largest number of threatened birds of any country in the world. Further field research may uncover even more species to add to this list, especially in view of the accelerating deforestation in Kalimantan**,** Sumatra and New Guinea.

Two hundred and one of Indonesia's 436 species of mammals--almost half-- are endemic, an amazingly high rate of endemism (Baillie and Groombridge 1996). Not surprisingly, Indonesia also leads the world in the number of threatened mammals--135 species, or 31 percent of all of its native mammals (Hilton-Taylor 2000). One thousand species of reptiles and amphibians live in Indonesia, 10 percent of the world's 10,484 herpetofauna (Collins 1990). Twenty-eight species of reptiles are considered threatened by the *2000 IUCN Red List Species*, along with at least 59 species of freshwater fish. Research on endangered amphibians, fish and invertebrates in tropical countries lags far behind that in temperate areas, and the endangered list of the latter species is likely to grow when further research is done.

Focus on Indonesia: Page 2

New Guinea has some of the largest expanses of ancient species of trees in the world, most of which grow in cool climates in highlands and mountains. One species of *Agathis* kauri from the highlands of Papua New Guinea is considered rare by the *1997 IUCN Red List Plants*, as are two more *Agathis* species in the Solomon Islands and Vanuatu to the southeast of New Guinea, also bits of Gondwana. The kauri pines (*Agathis macrophylla*) occur on both the latter island groups but have been logged over. Their close relatives on the island of Borneo are in steep decline from logging and land clearance. In New Guinea, logging and clearance for settlements or agriculture, and even native tribes, are destroying these giant trees. Known as "timber trees" in the IUCN-sponsored *Conservation Atlas of Tropical Forests. Asia and the Pacific* (Collins *et al.* 1991), the *Araucaria* pines, relatives of the Monkey Puzzle Tree, grow in groves in parts of New Guinea's highlands, and some tribes venerate them.

Zoologist Tim Flannery (1998) walked among these *Araucaria* trees near the highland village of Telefolip and reflected: "Around the edge of the grove they were saplings but, further in, the pines were soaring giants, mist swirling through their crowns. Their straight, clean boles carried patches of bright green moss, which contrasted with their walnut-colored bark . . . The most striking thing about the grove was the quality of the sound. It seemed as if, in an instant, we had left the noisy, muddy world of drizzle and people and entered a large, open-air cathedral." The grove was considered so sacred by the local tribe that not a single leaf, not even a mosquito, could be disturbed in it (Flannery 1998). They thought that all life had begun in the grove. In the middle of the grove, Flannery saw a rare bird of paradise displaying. The male Splendid Astrapia (*Astrapia splendidissima*) has iridescent colors on the breast and head, and long, dramatic tail feathers that are much desired by the native hunters. These birds are usually shy, but generations of Astrapias had learned that they could display in this sacred Araucaria grove without fear that they would be killed (Flannery 1998). Baptist missionaries worked to end what they called pagan beliefs and offered to purchase timber cut from this sacred grove; gradually they succeeded in ending the taboos. When Flannery visited the grove in 1992, a great fallen Araucaria lay near the path, its trunk hewn into segments with a chainsaw.

New Guinea's birds-of-paradise have been called the most spectacular birds in the world. They are confined to this island and its satellite islands, and extreme northern Queensland in Australia. Their dazzling plumage, showy courtship displays and haunting songs have inspired awe in all who see them. fiVoices in the Forest,fl a BBC film (see Video section, Birds), featuring these spectacular birds dramatically illustrates their conservation problems. Their feathers have been traditionally used for headdresses and costumes by natives, which has threatened some species. Commercial demand from outside the island for feathers, zoo and aviary birds and dried specimens poses additional threats to them. The entire family of these birds, Paradisaeidae, has been placed on CITES Appendix II to prevent illegal trade. Forest cutting poses an even more serious danger to birds-of-paradise populations. The majority of species inhabit primary rainforests, and many have extremely specialized habitat needs. As clearing continues, and logging roads open up more and more of New Guinea's forests, these birds lose their habitats and are more easily hunted. Four species of birds-of-paradise are listed as Vulnerable, and eight more as Near-threatened by BirdLife International; they comprise 28 percent of the 43 members of this avian family (BI 2000).

Less showy, but no less interesting, are New Guinea's bowerbirds. The constructions of bowerbirds are so elaborate that when explorers first encountered them, they were assumed to be man-made. Each species has variations on the construction, some building bowers with pass-through tunnels, others concentrating on accumulating a vast array of objects collected in piles of the same color to attract females. One very rare bowerbird, searched for in the wild on a dozen occasions, was finally found in the remote Foja Mountains by Dr. Jared M. Diamond of the University of California in 1979. This beautiful bird, the Golden-fronted Bowerbird (*Amblyornis flavifrons*), which may number only about 1,000 birds, is very restricted in range, limited to an area north of the Idenburg River between 1,000 and 2,000 meters (Beehler *et al.* 1986). The male of this species arranges sticks in a pile around a tree fern or sapling,

forming a tower up to 3.5 feet high on a circular moss platform with a raised rim. He clears the adjacent area of debris and places separate piles of blue, green and yellow fruits to attract the female. The blue fruit was also a newly discovered species. Making varied, loud calls even while holding a blue fruit in his beak, which contrasts boldly with his brilliant yellow head and back feathers, the Yellow-fronted Bowerbird perches near his elaborate bower performing for the drabber female.

An even more threatened bowerbird, Archbold's Bowerbird (*Archboldia papuensis*), ranges in the central mountain ranges of the island. The male has a long, forked tail and constructs a bower made of a large mat of ferns (Beehler *et al.* 1986). Inhabiting ancient *Nothofagus* beech forests, mixed with podocarps, bamboo and *Pandanus* at high altitudes between 2,300 and 2,900 meters, it has declined as a result of logging operations (BI 2000).

New Guinea's marsupials show great biological diversity, ranging from tree-kangaroos, an arboreal relative of the land kangaroos of Australia, to colorful cuscuses, tiny nocturnal possums and bandicoots. These fascinating mammals remained unknown to scientists until very recently as a result of the extremely rugged terrain, native tribes who were often unfriendly to outsiders, and the almost total lack of roads and other means of access. Many of these mammals are also secretive and nocturnal, hiding in the holes of giant trees covered in vines or inhabiting such restricted ranges that many have only recently been discovered after intensive searches in the wild. In 1865, for example, only 15 mammals had been named from New Guinea, and in 1875 that number had grown to 20 (Flannery 1995). By 1906, 126 mammals had been identified, including 50 marsupials and monotremes, but today it is known that at least 212 indigenous mammals inhabit New Guinea, many of which were discovered within the past decade (Flannery 1995). A surprising number of mammals inhabit a relatively small area and are threatened by forest loss and hunting.

Focus on Indonesia: Page 3

Thirty-eight marsupials and one monotreme (egg-laying mammal such as a platypus) are listed in the *2000 IUCN Red List Species*. One marsupial was previously unknown to scientists until 1994 when Tim Flannery (1998) discovered it in a remote mountainous area of Irian Jaya. This panda-like animal has long, fluffy black fur on its back and head, stripes of white on its belly and muzzle, and a white star on its forehead (see Flannery 1998 for color photo). It resembles no other tree-kangaroo and is also far more terrestrial than other species (Flannery 1998). The Moni tribe call it the "man of the forest," or Dingiso, because when threatened, it raises its arms above its head, exposing its white belly while letting out a whistle, which they consider a sign of recognition (Flannery 1998).

The Dingiso's scientific name, *Dendrolagus mbaiso*, means "forbidden" tree-kangaroo. The Moni believe it to be an ancestor and will not hunt it, but a neighboring tribe, the Dani, has no such taboo and kills the Dingisos for their fur, claws and tail tips. Weighing about 30 pounds and 30 inches tall, this fairly large tree-kangaroo lives in a dense, cloud pine forest up to 10,000 feet in altitude in the Maoke Mountain Range, an area where tree-kangaroos had never been seen. Within the territory of the Moni, this very tame tree-kangaroo is still common and can be easily approached by offering it some leaves; hunters take advantage of this trait by feeding it leaves and slipping a noose over its head (Flannery 1998). This beautiful animal is endangered, and should the protection of the Moni people end for some reason, it will likely become extinct, as it has already disappeared from the territory of the Dani tribe (Flannery 1998).

Focus on Indonesia: Page 4

Fig trees are among the most characteristic trees of Indonesia and other rainforests and are keystone species for wildlife. They are threatened by forest clearance and by loss of their seed dispersers. Some 800 species of fig trees

are found in tropical rainforests around the world. On Borneo alone, there are 140 species, 13 of which are endemic (Yates 1992). Among the tallest trees in these forests, they may attain a height of 150 feet. Strangler figs grow on the trunks of other trees, which they gradually kill by encircling them. All fig trees are dependent on wasps less than an inch long for pollination. (See "Borneo's Strangler Fig Trees," by Tim Laman in *National Geographic*, April 1997, which illustrates this pollination process in detail.)

A wide variety of birds and mammals feed on the abundant fig fruits, but few species actually disperse the seeds. Figs contain chemical compounds that have a laxative effect on the wildlife that eat them, a reproductive strategy designed to release seeds over a wide area. Animals as small as ants and as large as wild pigs, gibbons, and deer feed on the fruit (Laman 1997). Figs exist in such variety in unlogged, primary tropical forests that one species is always fruiting, supplying life-giving food to wildlife (Laman 1997). Hornbills may be more important than any other species in dispersing fig seeds because, rather than eating a portion of the fruit only, they eat the entire fruit, which is full of tiny fertile seeds, and then fly long distances, spreading the seeds in defecations. One ornithologist observed fruiting fig trees in Borneo with as many as 50 hornbills of eight species feeding together (Yates 1992).

Focus on Indonesia: Page 5

Hornbills also spread the seeds of other plants. In India, Great Pied Hornbills are vital to the dispersal of nutmeg seeds, since they are the only species with a beak large enough to open the seeds (Youth 1995). Ragupathy Kannan, a biologist studying this species in the Ghats region of southwestern India, discovered that the forestry department was intentionally cutting large fig trees in order to feed domestic Asian Elephants to haul lumber (Youth 1995). Kannan managed to convince them to ban fig tree cutting and, instead, to let Elephants browse freely in the forest (Youth 1995). If such conservation work took place throughout the ranges of hornbills, their future might be brighter.

The decline of hornbills throughout their Asian ranges highlights the loss of seed dispersers, as the forests themselves disappear or become logged over and fragmented. Hornbills are extraordinary birds, with their enormous beaks composed of horn-like material and, often, colorful facial markings. Some have a casque on top of the bill, giving the appearance of a double beak. The Rhinoceros Hornbill (*Buceros rhinoceros*), for example, has a typical downward-curving, white pointed beak, but atop it a bright orange-red casque curls upward at the tip like a rhinoceros horn. This species, native to Malaysia, Sumatra, Borneo and Java, has declined from trade and is listed on Appendix II of CITES. Averaging more than 4 feet long with 3-foot tails, hornbills make dramatic silhouettes as they fly over the forest canopy. Unfortunately, their size attracts hunters who kill them for sport or food, another factor in their rarity outside national parks. Their reproduction is highly unusual--unique, in fact--among birds. Courtship can involve spectacular head•on collisions between males, clashing their casques together. The hornbill pair, which mates for life, selects a nest hole high in a hollow tree, usually one that was created by a large limb falling off and the trunk area becoming rotted.

Since ideal nest sites are rare and found only in trees hundreds of years old, hornbills often use the same nest year after year. The female plasters the inside with droppings that harden, and the male plasters the outside, leaving a slit that effectively imprisons the female in the tree trunk hole for the next three months. She pokes her bill out to receive food from the male, who tips his beak into the female's open one and lets small round figs and other grape-sized fruits roll down. Other adults may help in feeding the chicks and female. Before the chicks are ready to fledge, the female breaks out and leaves the nest; the chick or chicks instinctively reseal themselves for another month, both parents continuing to feed them (Yates 1992). Finally, when ready, the chicks break out of the nest. It is thought that hornbills have evolved this method of reproduction to protect the female and young from tree•climbing predators, such as snakes and lizards. (The courtship behavior, nesting and feeding of the female and chick by the male Red-billed or Celebes Hornbill (*Penelopides exarhatus*) are beautifully photographed in the BBC film, fiCastaways of Sulawesi.fl See Video section.)

Hornbills, so important to fig trees and the host of species that feed on them, are themselves dependent on primary rainforest (Collins 1990). Their nest trees are often intentionally cut to obtain chicks for sale to zoos and in open wildlife markets. When these great trees crash down, they bring with them many adjoining trees, killing small mammals and birds in the process. The dual threats to hornbills of habitat loss and capture have resulted in dramatic declines in their populations. Should all the hornbill species that are threatened become extinct, the extinction of hundreds of other species may result, from the fig trees, whose seeds they spread, to many vertebrates and invertebrates. In 1980, only one species, the east Asian Helmeted Hornbill (*Buceros vigil*), was listed as Indeterminate by the International Council for Bird Preservation (ICBP) (now BirdLife International) as a result of killing to use their large casques for carving (King 1980). But by 1988, that organization listed seven Asian hornbills as threatened with extinction (Collar and Andrew 1988). In 2000, 18 of Asia's 30 species, or 60 percent, of hornbills were listed in *Threatened Birds of the World* (BI 2000). Seven of the 10 Philippine endemic hornbill species are threatened with extinction (BI 2000). The dramatic increase in threat to these keystone rainforest birds is a reflection of the destruction of Asia's rainforests.

Focus on Indonesia: Page 6

Other rare and declining inhabitants of Asia's rainforests play important roles in pollination. Many trees that produce important commercial products need to be pollinated by wild animals. An extremely valuable fruit is the Durian, which is almost unknown outside southeast Asia. In spite of a rank odor emanating from the outer fruit, the yellow core inside the rind is considered a great delicacy, worth more than $90 million a year in markets throughout Indonesia and Malaysia. What is less well known is the dependence of the Durian tree on a particular species of bat to pollinate it. The Cave Fruit Bat (*Eonycteris spelaea*) is the sole pollinator of these valuable trees, pollinating the flowers while feeding on the nectar of the flowering fruit. Yet this bat is unprotected from the persecution, hunting for food and destruction of its limestone caves that are causing its decline. The number of threatened bat species native to Asia has increased dramatically in recent years, according to the IUCN (Hilton-Taylor 2000). Throughout these rainforests, bats are disappearing, some before their ecological role was known.

Hundreds of tropical plants and trees have evolved for pollination by bats. Most flowers of such trees are found in the canopy, giving easy access to the nectar•feeding and fruit bats, either hanging on long stems, set clear of the surrounding foliage, or clustered on branch tips near twigs where bats can land (Mitchell 1986). These bat flowers open only at night, with odors quite unlike the day•blooming flowers that attract insects and birds; instead, they are musky and sour, which seem to attract the bats (Mitchell 1986). Evolved with shapes that conform to the muzzle of the bat in order to deposit pollen on the bat's face, some flowers have large, trumpet•like openings that almost engulf the bat's head. Others are brush•like with masses of stamens rich in pollen, while still others have numerous small flowers in a ball•like inflorescence producing both nectar and pollen (Mitchell 1986).

The trees that have evolved to be pollinated by bats, some even by a particular species of bat, while providing food for the bats, represent a classic example of mutual dependency. Current logging practices and the killing of many of these bats for food, or destruction of their caves, endanger both trees and bats. Many of Indonesia's threatened bats are fruit bats, and a large number are found only in Indonesia. The Pygmy Fruit Bat (*Aethalops alecto*), for example, is found only on Borneo; the Small•toothed Fruit Bat (*Neopteryx frosti*) is native to Sulawesi; the Javan Tail•less Fruit Bat (*Megaerops kusnotoi*) is restricted to Java; four others are confined to the island of New Guinea. Half of Borneo's 140 mammal species are bats, and more than 50 of these feed primarily on insects (Yates 1992), another major benefit of these poorly understood mammals.

Focus on Indonesia: Page 7

The threats to Indonesia's environment are strongly linked to the growth of its human populations. With the largest number of people on Sumatra, Java and Bali, lowland forests on these islands were cut for cities and farmland during the first half of the 20th century (Collins *et al.* 1991). Beginning in the 1960s, industrial, government-sponsored logging began on many islands for valuable timber. Uncontrolled logging and wildfires have consumed millions of acres for decades, destroying 44 percent of original habitats and nearly all the lowland rainforests in Indonesia (Mittermeier *et al.* 1999a). Java has become nearly denuded, due mainly to the massive growth in human population that totals more than 110 million, almost half the entire population of the United States (Mydans 1996a). The tiny satellite island of Bali has similar crowding problems, and very little forest remains. Between 65 and 80 percent of Sumatra's lowland forests have been cleared to make way for the ever-expanding human population (Collins *et al.* 1991). By June 2000, an estimated 224.8 million people inhabited Indonesia, the equivalent of 82 percent of the US population, living on 741,000 square miles, or 20 percent of the US land area (New York Times 2000).

Among the first casualties of this deforestation and population growth were Tigers, who numbered in the thousands on Sumatra, Java and Bali up until 1900. The populations of each island had been separated for at least 8,000 years (Matthiessen 2000), as each evolved into a separate race. The Javan (*Panthera tigris sondaica*) and Bali Tigers (*Panthera tigris balica*) were far smaller than other Tiger races, with males weighing only about 200 pounds, one•fourth the size of a male Siberian Tiger. Several Javan Tigers were kept in the Berlin Zoo in the early 1900s without any effort to breed them in captivity (see photo in Tilson and Christie 1999). After massive deforestation of these islands and heavy hunting pressure, their populations crashed (Simon and Geroudet 1970). Udjung Kulon, a large national park, was set aside for the Javan Tiger in 1921, but only 20 to 25 of the species survived by 1955, of which 10 were in this park (Simon and Geroudet 1970). By the 1970s, they had disappeared from Udjong Kulon, and only a few were left in Meru Betiri National Park in the far south. In 1980 a careful survey found tracks of at least three Javan Tigers, but there have been no signs since (Jackson 1990). Bali Tigers were once common in the western portion of the island, but not since 1952 has there been a confirmed report (Simon and Geroudet 1970). Both these races are now considered extinct in the wild, and none survives in zoos (Jackson 1990). These Tigers represented unique genetic strains that are now lost forever. They were the chief predators at the top of their food chain, and their loss impoverished these ecosystems.

The Sumatran Tiger (*Panthera tigris sumatrae*), the largest of the three, is the only surviving Indonesian Tiger. Highly endangered (Jackson 1990), its wild population may total only 500 or fewer animals (Nyhus *et al.* 1999). An intensive conservation program, begun in 1995, involves an international team of biologists who are attempting to determine just how many Tigers are left, whether they have sufficient prey species, how many are being killed by local people and the status of their habitat (Franklin *et al.* 1999). In Way Kambas National Park in the southeast, researchers, using cameras placed on trails, have photographed them. An estimated 36 Tigers inhabit the second-growth forest and degraded grassland habitat in this park of about 1,500 square kilometers. It is completely surrounded by villages, and nearly all its lowland primary rainforest has been cut (Franklin *et al.* 1999). Villagers resent the park's ban on using forest and grassland products, and when Tigers prey on livestock, often because of a lack of natural prey, the villagers put out poison. Sumatra's forest fires and rampant poaching of all large animals in Indonesia may extinguish the last of these Tigers, but the conservation research program intends to involve local villagers in saving the Sumatran Tiger and help address many of their needs in the process (Franklin *et al.* 1999). This race of Tiger is kept in many zoos around the world, unlike the Bali and Java Tigers, and has reproduced. The fragmentation of the forest range of Tigers throughout Asia to India has isolated populations, caused inbreeding, and exposed them to poaching, even in national parks.

The parks created for the Javan and Bali Tigers protect a great diversity of other wildlife and plants. Meru Betiri

National Park preserves the last remnants of lowland rainforest in Java (Whitten and Whitten 1992). A population of about 75 to 100 endangered wild cattle, or Banteng (*Bos javanicus*), and Leopards (*Panthera pardus*) are also resident (Whitten and Whitten 1992). Unfortunately, illegal cutting of trees and rattan within the Meru Betiri National Park has been extremely destructive (Whitten and Whitten 1992). Udjung Kulon National Park on the western tip of Java is home to a small population of Javan Rhinoceros (*Rhinoceros sondaicus*), the rarest of all rhinoceros, along with Sambar Deer (*Cervus unicolor*) and Barking Deer (*Muntiacus muntjak*) and Banteng (Whitten and Whitten 1992). Sumatra has several important national parks as well. Mount Leuser National Park's swamp forests protect the last Sumatran Rhinoceros (*Dicerorhinus sumatrensis*), second rarest of the rhinos. This extremely primitive and hairy rhinoceros has been captured for zoos, where most have died and none has been born in captivity. Researchers in the park have tried to prevent further captures of these highly aquatic rhinos in order to preserve the last wild members of the species. This park also has resident Orangutans (*Pongo pygmaeus*), Siamangs (*Hylobates syndactylus*) and endangered Sun Bears (*Helarctos malayanus*). Unfortunately, some of Sumatra's national parks have been overrun with people cutting trees, causing erosion, and replacing forest with agriculture. The Kerinci-Seblat National Park, located along a mountain range in southern Sumatra, encompasses 14,847 square kilometers of forest, but within the park is a virtual city of 273,000 people, growing at a rate of 3.6 percent a year, who denude the hillsides and convert forest to cinnamon, cloves and coffee. They are gradually destroying this entire forest and the watersheds of the island's two most important rivers (Collins *et al.* 1991).

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Until about 30 years ago, Borneo had extensive, unspoiled and magnificent forests. The third largest island in the world after Greenland and New Guinea, it covers 215,000 square miles (Smythies 1960). Prior to recent logging and forest fires, it was described as "one enormous forest" by Bertram E. Smythies, author of *The Birds of Borneo* (1960); 75 percent of the island was primary forest, and 10 to 15 percent, secondary forest (Smythies 1960). Mangrove forests grew abundantly along the southern and southeastern coasts, extending far inland, lining major rivers and blending into vast swamp•forests (Yates 1992).

By the late 1970s, an estimated 66 million acres of the country's forests had been classified as denuded (Allen 1980). Forest clearance on Borneo and in Sumatra took a dramatic turn in the early 1980s when landowners and settlers set fire to forests felled for commercial timber, palm oil and tree plantations and homesteads to destroy stumps and brush. This was done in spite of a law banning the setting of fires. The largest forest fire ever recorded on Earth took place in the old-growth forests of Borneo during 1982-83 and lasted for 18 months (Collins *et al.* 1991). More than 9 million acres, or 33,000 square kilometers, were destroyed in east Kalimantan, including 8,000 square kilometers of unlogged dryland primary rainforest and 5,500 square kilometers of peat swamp forest; the rest was selectively logged forest and settlement areas (Collins *et al.* 1991). This was the first time that living rainforest had been seen to burn. Half the new Kutai National Park was destroyed, and another 2.5 million acres burned in Sabah in the northwest of Borneo (Yates 1992). Wildlife was seriously affected, and some burned land was later converted to tree plantations (Collins *et al.* 1991).

During the 1990s, more fires erupted, spreading to adjoining forests. Logging practices involved the removal of the largest trees, leaving leaf litter, small trees and broken branches that dry out (Paul 1998). The logging opened up the canopy, allowing further drying-out of the forest floor, and humidity dropped (Paul 1998). Fires set in clearcuts entered logged rainforest through these logging openings, setting the entire forest afire (Paul 1998). In 1991, another 190 square miles of East Kalimantan burned, and in 1995, massive fires broke out in Kalimantan and Sumtra (Paul 1998). Two years later, an estimated 750,000 to 1.5 million acres of forest burned in Sumatra and Kalimantan (Howe 1997), including a devastating fire in Tanjung Puting National Park, a prime refuge for Orangutans (Paul 1998). So immense were these wildfires that the smoke spread to neighboring countries, causing severe air pollution in cities and towns, and the fires were seen clearly from satellites orbiting the Earth. A Canadian observer from a vessel in the

China Sea during these fires wrote to *National Geographic* (December 1998): "Even at 250 kilometers [155 miles] distance from the coast of Kalimantan, the air was thick with smoke. For nearly three weeks we could not see the sun's disk, only smoke-diffused light. The most astonishing and sad event we witnessed happened one night when we were surveying . . . Our ship was engulfed by an ever increasing flock of exhausted birds and bats, all fleeing the fires of Sumatra. Dozens of birds landed all over the deck, where, too fatigued to move, they could easily be approached and handled. In the morning we found several tired bats dangling from overhead steel gratings. I sincerely hope that a new and more benign Indonesian government will prevent such awful, and needless, environmental calamities from happening again" (Christopher Woodworth).

In Borneo and Sumatra alone, 14.8 million acres are estimated to have been destroyed prior to 1998, still charred and black years afterward (Paul 1998). A zoology student and his girlfriend traveled across Kalimantan in the late 1990s, seeing no green except along roads--small farms and banana trees (Paul 1998). In parts of the region, underground fires burn for years, igniting deep beds of peat and coal seams. The Indonesian government's reforestation funds were rerouted, first by President Suharto, then by his successor, President Habibie, to develop industrial oil palm and timber estates (Paul 1998).

After worldwide publicity and protests from other countries about the fires, and condemnation of Indonesia's failure to act against those responsible, in early October 1997, the government revoked the operating permits of 29 companies that had set illegal fires. This had little effect on fire-setting, as more fires broke out in the following year. In 1998, another million acres burned, and in 1999, an area the size of Vermont and New Hampshire burned on Borneo. In the summer of 2000, smoke from Indonesia's illegal forest fires again blanketed nearby Malaysia's capital, Kuala Lumpur, and Singapore (Mydans 2000). After the fires, floods made the forest loss in Kalimantan permanent by washing away soil, leaf litter and nutrients from the fires ashes (Kaplan and Rogers 2000). Exotic Imperata grasses took hold in many areas, poisoning the ground with substances that inhibit the growth of trees, signaling the end of the rainforest (Kaplan and Rogers 2000). Some 80 percent of the forests in the southeast of Borneo are now gone.

During these fires, wildlife, including such critically endangered species as Sumatran Tigers, Orangutans (*Pongo pygmaeus*) and Asian Elephants (*Elaphus maximus*), fled the fires into villages, where many were killed or captured for sale as meat or pets. Stephanie Fried, a scientist with the Environmental Defense Fund in Washington, DC, who has studied the timber trade in Indonesia, described these fires as the result of "appalling forestry practices and rapacious greed" (Howe 1997).

The fires destroyed most of Borneo's lowland rainforests, where 267 of the world's 600 dipterocarp trees, or trees with "two•winged fruits," dominate; 150 of these exist nowhere else (Whitten and Whitten 1992). This family of trees, Dipterocarpaceae, has species from the Seychelles to New Guinea, but Borneo has by far the most species (Whitten and Whitten 1992). Many reach heights of 250 feet or more and are pollinated by tiny thrip insects. They are extremely important to wildlife, producing fruits, flowers and digestible leaves that are fed on by birds, gibbons and a variety of other animals (Whitten and Whitten 1992). Each year, 2,500 square kilometers of dipterocarp forest are logged in Sarawak, and these old-growth forests are often replaced with tree plantations (Collins *et al.* 1991). Elsewhere in Indonesia, these are the preferred trees to be logged, with their unbranched, wide trunks used in furniture, plywood, resins and camphor (Whitten and Whitten 1992). It was almost inevitable that many of these trees became extinct. The *1997 IUCN Red List Plants* lists a dipterocarp trees native to west Sumatra as Extinct. Another species is extinct on Sumatra but still survives in Peninsular Malaysia, along with 95 other members of the family listed as Threatened or Extinct on the island of Borneo and the rest of Indonesia. Four species of the giant kauri *Agathis* that grow in Borneo's higher altitude forests are also threatened with extinction (Walter and Gillett 1998).

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Orangutans once ranged in mainland southeast Asia as well as Indonesia, but hunting and forest cutting eliminated them from 98 percent of their original territory, leaving populations only on Sumatra and Borneo. These islands were home to tens of thousands of Orangutans at the turn of the century, but since then, these intelligent apes have been pushed into pockets of shrinking rainforest. Orangutans are unable to adjust to second-growth forest and depend on very large ranges within primary rainforest, where they feed on ripe fruit and flowers. Their populations have become scattered from loss of old-growth forest, and even national parks are no longer safe havens for them, as poaching and illegal logging increased in the late 1990s. Orangutan populations decline between 60 percent and 95 percent in selectively logged forests (Newman *et al.* 2000). The logging scares them out of their territories, and they often die of starvation or accidents (Newman *et al*. 2000).

One of their former strongholds was the Tanjung Puting National Park, 741,000 acres on a peninsula on the south coast of Borneo. It was upgraded to national park status in 1982, primarily to protect the Orangutan. This is the largest swamp forest in southeast Asia, with a mosaic of habitats, including primary rainforests. The Environmental Investigation Agency (EIA) of London conducted an in-depth study of illegal logging in this park, publishing a report, *The Final Cut*, in 1999 (Newman *et al.* 1999). Illegal loggers were so blatant that they built a wooden railway to slide out the giant logs. When government officials were notified, they did nothing, as they had apparently been corrupted by bribes from the loggers (Newman *et al*. 1999). In December 1999, biologists in the park found themselves ordered by armed loggers to leave. Similar illegal logging took place in other parks and reserves crucial to the survival of the Orangutan, leaving few areas not seriously degraded (Newman *et al*. 1999). EIA turned over to Indonesian government authorities, including the Governor of the Province, copies of its detailed report on illegal logging, which had uncovered the fact that 70 percent of the timber being processed in Indonesia came from illegal logging (Newman *et al*. 2000).

The World Bank in Jakarta estimated that between 1985 and 1997, Indonesia lost an average of 1.5 million hectares of forest cover every year, with dry tropical forest, an endangered ecosystem, suffering the greatest losses. Sulawesi has been logged out, and this forest type could disappear from Sumatra and Kalimantan in the near future (Newman *et al.* 2000). Logging supplies 2 million cubic meters of timber to its many pulp mills (Mittermeier *et al.* 1999a). The lack of strong government control has allowed corrupt timber barons to emerge and control the rampant illegal logging that is leaving little of the country untouched (Newman *et al.* 2000). In spite of international publicity about this disastrous state of affairs, and pressure from international donor agencies, the Indonesian Government stated that it would stop the illegal logging, but did not take action. The bribery scandal apparently reaches into high levels within the government (Newman *et al.* 2000). In May 2000, student activists, frustrated by the government complicity in the looting of their national heritage, held four government officials at a port in West Kalimantan after Customs and other officials failed to halt the shipment of an illegal consignment of timber to Singapore. This shipment, with 70 containers of logs, was forced to return to port and its cargo seized (Newman *et al.* 2000). China and the European Union import more than half the timber exported from Indonesia, and to date, no action has taken place by importing countries to confiscate illegal shipments of timber (Newman *et al.* 2000).

The status of Orangutans has gone from endangered to critical. Decades of logging, clearing and forest fires have destroyed the majority of their primary, old-growth forests on Borneo and Sumatra. Thousands were killed during these fires and hundreds that fled burning forests and entered open areas near villages were killed by villagers wielding machetes. Mothers were hacked to death to obtain their babies, who were often wounded in the process. Hundreds of orphaned Orangutans, pitiful, sickly and malnourished, were confiscated during this period and placed in rehabilitation centers. Many died, and the traumatized survivors clung to one another in crowded pens and crates, mass fed by volunteers and workers of these centers. The Leakey Research and Rehabilitation Center for Orangutans in southern Borneo, and two other centers on the island, have cared for hundreds of these orphans. In 1997, the Wanariset Orangutan Reintroduction Project in East Kalimantan received 118 baby Orangutans, and in 1998, 60 more arrived (Paul 1998). In August, 1998, the station held 171 refugee and injured Orangutans, most very young (Kaplan and Rogers 2000). Many mother Orangutans died of starvation, trying to sustain themselves on acacia bark, and their young were so weak they could hold on no longer and fell to the ground. Some mothers were eaten by the starving

local people, and others succumbed to disease (Kaplan and Rogers 2000). Even those saved and rehabilitated have a low rate of survival. Fewer than half survive in the wild, according to Martinus de Kam, site manager of the Wanariset Forestry Research Project (Paul 1998).

Birute Galdikas, a renowned primatologist and the world's foremost expert on the species, runs the Leakey center and was almost overwhelmed by the numbers of orphans to care for. Moreover, quite a few Orangutans that had been rehabilitated over the past decade and returned to the rainforest came back to the Leakey center for food as their forests were burned or fruit trees cut. In the early 1990s, Orangutan populations were estimated at more than 22,000, with 9,200 on Sumatra and up to 15,546 on Borneo (Nowak 1999). Few believe that more than 15,000 survived the forest destruction and fires of the late 20th century. Galdikas has stated that the species may be doomed to extinction, left with too little habitat to survive. Two primatologists, Gisela Kaplan and Lesley J. Rogers (2000), who have studied Orangutans for many years, conclude that these fires may have been enough to set the final scene for their extinction in Borneo before too many years. Wild populations are unable to sustain the removal of so many female Orangutans. Their reproduction is among the slowest of any mammal. Males are solitary, and females live with their single young for eight to nine years before having another baby (Kuznik 1997). A loss rate of only five Orangutan females out of 1,000 per year can cause a stable population to decline, according to Mark Leighton, a Harvard ecologist conducting research in Borneo's rainforests (Kaplan and Rogers 2000). This rate was surpassed many times during the 1990s. This picture has been further complicated by the recent genetic analysis of Orangutan DNA, which has revealed that there are two, not one species: the Sumatran has been renamed (*Pongo abelii*) and the Bornean retains the original scientific name, *Pongo pygmaeus*. These two primates have been long separated from one another and developed changes in their genes that warrant separating them as species (Kaplan and Rogers 2000; Hilton-Taylor 2000). There are physical differences as well. The Bornean Orangutan is far larger than the Sumatran, perhaps because it has not had to be agile to flee from Tigers, since the species is absent on Borneo. Both species are listed in the *2000 IUCN Red List Species*, the Sumatran as Critical and the Bornean as Endangered.

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Many islands, including Borneo (Kalimantan), Sulawesi and western New Guinea have had to absorb millions of people relocated from overpopulated Java under a government program. Beginning in 1978 with partial funding from the World Bank, more than 100,000 people per year were relocated to these and other out-islands costing $2 billion by 1992 (Durrell 1992). By 1996, 6 million people had been relocated from Java; Sumatra received the greatest number of people, followed by Kalimantan, Sulawesi and Irian Jaya (Mydans 1996a).

Irian Jaya™s 350,000 square kilometers of forests are still largely intact, but they are rapidly being destroyed by settlers. More than 250,000 people have been sent here, pushing aside the native New Guinea tribes who have witnessed their pristine rainforests cleared, even on steep slopes, for subsistence farming (O'Neill 1996). One tribesman said, "While we believe we are descended from the forest, most Indonesians believe that devils live in the forest and that the forest must be destroyed" (O'Neill 1996). The Indonesian government clearcuts 5 acres of forest for each family and supplies tin shacks, seeds and tools (O'Neill 1996); these shacks are lined up in rows on the remnants of the rainforest that once rang with the calls of birds-of-paradise. Villagers are encouraged to cut trees and are paid $1.30 for each tree by the government (O'Neill 1996). Roads, schools, clinics and other modernizations are planned, and towns of up to 250,000 people are being carved out of the virgin rainforest (Flannery 1998). New Guinea tribespeople are resentful about the forest cutting and have documented many instances of killing and cruel treatment they have received from the Indonesian military (Flannery 1998). They believe that Indonesia has invaded their lands, and they have organized a resistance movement, demanding that the land be returned to them (Flannery 1998).

The relocation program has been a dismal failure, not only for the people who were unable to farm the thin,

infertile soil of cleared rainforests, but for the devastated environment and wildlife (Durrell 1992, Flannery 1998). The rainforest is not the only ecosystem that has been destroyed by these settlers. On heath and sandstone ridges on Borneo, stands of Ironwood (*Eusideroxylon zwangeri*) grow. These are very unusual trees for tropical areas (Mittermeier *et al.* 1999a). Many of the Javan immigrants are unhappy with the conditions of their new lives and return home (Mydans 1996a). Irian Jaya is expected to remain a center for relocation, however, since only 4 million people live here, and the giant Freeport mine that has removed entire forests employs large numbers of people who come from abroad to work in the mines, living in air-conditioned, newly built homes. Family planning over the past decade reduced the rate of growth on Java from 2.1 percent to 1.5 percent, or half a million fewer births every year (Durrell 1992), but an influx of as many as 1 million people a year still flood into Java from elsewhere in Indonesia and Southeast Asia (Mydans 1996a). Had Indonesia devoted more of its financial resources to family planning a generation ago, as did Singapore, which now has a stable population with a low birth rate, the highly expensive relocation program would not even have been considered.

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The future of Indonesia's forests and their wildlife may be as bleak as that of other tropical forests in the Philippines, Thailand, West Africa and many parts of Latin America and the Caribbean. The disappearance and endangerment of large, wide-ranging mammals, followed by fragmentation and loss of the fauna and flora of entire regions, is a pattern that is being repeated here. The government has set aside many national parks, but as in other parts of the world, they are rarely given a high priority for protection, and local people are allowed to log and even establish agriculture plantings and villages within them. The native tribes of Papua and Kalimantan may force a change in the attitude of the government toward the forests and even end in a return of the land to the people who have lived there for thousands of years and have a strong bond with the native trees and animals. Violence has broken out between natives and immigrants on both islands, leading to the forced departure of hundreds of people in Kalimantan after many were killed by Dyak tribesmen in 2001. In Papua New Guinea, international rainforest organizations have become allied with native tribes in fighting corporate loggers from Australia, and they have been successful in taking legal actions that negated corrupt agreements made between their own leaders and the loggers.

The potential for ecotourism in Indonesia is great. The islands are already a major draw for tourists, spending more than $1 billion per year. A powerful movement for democracy is making strides in the country, and with more help from the United States and other democracies of the world, this would become a reality. With a radical change in Indonesia's government, priorities might change to benefit the Indonesian people and their environment instead of making the rich richer at the expense of biodiversity. If that happened, more and more people would learn the value of preserving forests and the country's extraordinary biodiversity for their own benefit as well as that of the entire world. The thin, tropical soils of the country have proven to be best for growing trees, and when this is better appreciated, the tide may turn.

Strong and immediate action is required, however, to prevent biological diversity losses that will dwarf those of any other area on Earth. Stabilizing the human population would be a major step in the right direction. By 2025, it is projected that Indonesia's population will exceed 275 million (Mittermeier *et al.* 1999a). If the government does not stop the disastrous and unsuccessful resettlement program, there will be no wilderness forests left, and the remotest national parks will be invaded for tree and rattan cutting and other destructive uses that will inevitably cause massive animal and plant extinctions.

The participation of international conservation organizations in programs to educate Indonesians to live in harmony with nature and to protect biodiversity is in its early stages. Several of these groups have helped produce field guides, books, posters, pamphlets and textbooks, and the series *Ecology of Indonesia*, in Indonesian (Mittermeier *et al.* 1999a). Protected areas total about 110,000 square kilometers, and the important work of protecting them from

encroachment and destruction is being aided by projects such as The Nature Conservancy (TNC) work in a huge, 231,000-hectare national park in southern Sulawesi, Lore Lindu National Park (Mittermeier *et al.* 1999a). In cooperation with the government conservation agency and local groups, TNC is conducting a comprehensive education program that also encourages butterfly farming and ecotourism to stem forest clearing and rattan collection (Mittermeier *et al.* 1999a). Other programs to encourage ecotourism and create sustainable models for local economies have been launched. In some cases, international programs have failed. In the 1980s, the World Bank funded a program to protect a 300,000-hectare national park in northern Sulawesi and help local farmers irrigate rice fields while protecting the watershed. These worked at first, but enforcement lagged and gold miners have entered the park and poisoned rivers with mercury. Forest clearing, hunting and rattan collection have also occurred within the park (Mittermeier *et al.* 1999a). Emergency programs to stop incursions into national parks are needed.

A new and potentially major source of income to benefit wildlife and the environment involves the placement of videocameras connected to the Internet in wilderness areas. These cameras can be solar-powered and placed in tree tops, animal dens, waterfalls or other attractions. Such videocameras, using satellites to beam live pictures or web pages to Internet users around the world for a small fee, are helping to finance the conservation work of national parks in South Africa and Central America. Internet users have increased exponentially in the past decade and are expected to continue to grow in number. Many "surf" the Internet for amusement, while others seek wilderness views or natural history information. If the funds were managed so as to be devoted entirely to protection of the environment and related programs, many millions of dollars could accrue. A conservation organization could publicize the fate of a particular species, group of species or region to raise funds for its protection. Certainly Indonesia has hundreds of appealing animals. Orangutans, Sumatran Tigers, Proboscis Monkeys, gibbons, Babirusa, tiny deer, cockatoos and parrots (some as small as sparrows), birds-of-paradise, bower birds and Komodo Dragons are among animals that could appeal to millions of people around the world. Spectacular and magnificent coral reefs, ancient forests, giant flowers, carnivorous plants, mangroves and wild rivers could also be filmed for the Internet. An Internet site could have biodiversity data for students and the general public and lists of projects that need financial aid. Ecotourism opportunities could also be part of this site.

On behalf of American consumers and those in Japan and countries importing plywood and concrete forms from Indonesia, conservationists could approach importers, building companies, stores and builders to propose substitutes. In many cases, users of these products have little idea where they came from or the effect their purchase has on forests half a world away. The key to saving Indonesia's wild heritage lies in making it more profitable to conserve it than destroy it, and educating these already highly literate people to preserve their own future in the process.

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Forest

Introduction

In an Ecuadorian rainforest, great towering trees festooned with orchids whir with hummingbirds. Primitive mammals skitter up massive Australian trees of species older than the dinosaurs. The world's tallest trees grow in northern California; at the forest floor beneath them grows an intricate diversity of emerald green mosses and ferns inhabited by tiny creatures. At the southern end of the South American continent, a forest of small gnarled trees buffeted by sea winds shelters herds of short-legged Huemul deer. Kiwis, in their downy cloaks of brown feathers, probe the forest litter among giant tree ferns in New Zealand's dark rainforests, pushing their long, pointed bills into the soil to extract earthworms. Monkeys with elaborate facial patterns, in blues, reds and blacks, chatter in treetops above a plodding West African elephant herd. New Guinea's dazzling birdwing butterflies, measuring 1 foot across, flutter near moss-hung trees where iridescent birds-of-paradise display and utter resounding, eerie calls. Thousands of insects and hundreds of other life forms may inhabit a single tree, whose fruits and flowers feed countless other animals, each the

product of eons of evolution and geological history. These irreplaceable forests are in imminent danger of disappearing. The most biologically diverse of these are the untouched, old-growth forests of the world, of which only 20 percent remain, largely unprotected from destruction.

Benefits of Forests

The great beauty and inspirational qualities of forests belie their important biological tasks. By producing vast amounts of oxygen and water vapor, and absorbing carbon dioxide, they help support all life on Earth. A single mature oak tree produces enough oxygen to keep eight people alive for a year. In 1995, an international team of ecologists working in Brazil documented that each hectare (2.47 acres) of undisturbed tropical rainforests absorbs 1 ton of carbon dioxide per year. The world's rainforests are thus absorbing a billion tons of carbon dioxide a year, one-sixth the amount produced by burning fossil fuels such as oil and coal, according to the National Oceanic and Atmospheric Administration (NOAA). Cutting and burning of forests around the world releases carbon dioxide into the air. The high levels of carbon dioxide in the world's atmosphere have caused increases in average global temperatures. The value of tropical forests in trapping carbon dioxide is so significant that four US utility companies have sponsored a pilot program in Belize to protect large areas of forest and plant trees; energy companies will contribute $2.6 million to a 120,000-acre reserve that will absorb 5.2 million tons of carbon dioxide gas over 40 years (Geatz 1996). The Clean Air Act allows such "pollution credits" to compensate for pollution released elsewhere. In 2000, the US government proposed a massive program of tree planting and protection of forests to compensate for the effects of global warming caused by the release of carbon dioxide and other pollutants.

The cooling effect of forests results from leaf transpiration generating moisture that rises to the atmosphere, forming clouds which release water as rain or other precipitation. When forests are cut, the climate dries as rainfall decreases and soils lose moisture. Tree roots absorb about one•half of the rain that falls, releasing the water gradually during the year (Schreiber *et al*. 1989). In countries with wet and dry seasons, water retention by trees makes the difference between deadly floods that kill thousands of people and sweep away their homes and precious topsoil, and river levels that remain stable, preserving soil and the environment. Forests stabilize the soil, preventing erosion and landslides and allowing streams and rivers to flow clear.

The leaves, bark and wood of trees have been found to contain hundreds of compounds valuable to medicine and industry. Forests produce a wealth of useful species: oils, gums, resins, tannins, waxes, edible oils, dyes, cosmetics, spices, fruits, nuts and life•saving compounds used in medicine. Spices alone are worth more than $1 billion per year (Schreiber *et al*. 1989). Medications derived from wild plants are worth $40 billion annually (Lean and Hinrichsen 1994). Painkillers, birth•control agents and malaria drugs, as well as quinine, digitalis and morphine, are all derived from tropical forest plants. According to one study, more than 40 percent of all prescriptions in the United States still depend on natural plant sources (Swaminathan 1990). Only a small percentage of wild plants have been tested for medicinal value. In some cases, plants that might have disappeared altogether were found to be medical treasures. The Madagascar periwinkle, native to an island which has lost 80 percent of its forests to deforestation, has been the source of two potent compounds that have proven effective in the treatment of Hodgkin's disease and produce a 99 percent remission in patients with acute lymphocytic leukemia (Myers 1983). Global sales of these two drugs now exceed $180 million a year (Wilson 1992). Taxol, a compound from the Pacific Yew found in the last of North America's old-growth forests, has proven effective against ovarian and other cancers.

In the long run, forests left standing are of greater benefit than those cut and destroyed. The dollar value of natural ecological systems, of which forests make up a large part, in performing services for human society has been estimated at as much as $54 trillion, as seen in Chapter 1 ("Earth's Worth" section). Along with their role in flood prevention and climate regulation, forests provide fruits and flowers to be pollinated by wild insects and birds, and

clear rivers as habitat for valuable salmon and trout fisheries (Stevens 1997b). The World Resources Institute in Washington, DC, has calculated that the loss of value from deforestation is four times as high as the value of the timber extracted and the depletion of soils, forests and fisheries amounted to an average reduction of 25 to 30 percent in potential economic growth (Stevens 1997b).

The ways in which forests function are only beginning to be understood. Great fig trees are dependent on tiny wasps to complete their reproduction, and fungi in the roots of trees play intrinsic roles in their survival. Pollinators are key to the health of forests, but for many species of trees and plants, only fragmentary information has been acquired about how they are pollinated and the conservation status of these pollinators. Understanding the interrelationships of plants and animals within these ecosystems is key to their preservation, yet forest ecology is in its infancy.

While logic would seem to mandate that such awesome and useful ecosystems be accorded great respect and legal protection, the opposite is true. They are being destroyed so rapidly by logging, dams, climatic changes caused by human activity, and pollution that the last pristine forests may soon be gone. Even minor alterations in their environments have interfered with their healthy functioning.

Cutting forests for financial gain or to resettle people from overpopulated cities provides developing countries with short-term solutions to problems and one-time profits. Neither the extremely important ecological roles that forests play, nor their value as species storehouses, are appreciated by the majority of the world's nations. The recent spate of massive landslides and floods after periods of heavy rains in countries around the world has, in most cases, been traced to logging that left hillsides and entire regions open to erosion. Millions of people have been left homeless around the world in recent years, and thousands have lost their lives to such floods. These floods may be only a prelude to far more serious and long-lasting consequences of forest destruction. Global warming will increase as forests vanish, especially with the cutting of old-growth trees, which have immense canopies for absorbing carbon dioxide and cooling the atmosphere. Higher temperatures have already brought droughts, increased desertification and caused rivers and streams to lose volume and even dry up. The loss of potential disease cures is another byproduct of destroying forests, and the destruction of these beautiful environments, with their multitude of life forms, may result in collapsed ecosystems that cannot be restored.

Forests' Retreat

As recently as 1960, forests covered one•fourth of the Earth's land surface (CEQ 1980). With continued logging and clearance, two decades later, in 1980, only one•fifth remained forested (CEQ 1980). Since then, forests have continued their decline, losing more than 5 million square miles since 1960. During the last quarter-century alone, the world's forests have shrunk the equivalent of one-half the land area of the United States.

This destruction has threatened thousands of animals and plants with extinction. In fact, forests have the greatest number of endangered species of any ecosystem. Of all types of forests, primary, old-growth forests, especially tropical rainforests, harbor the greatest wildlife and plant diversity and the greatest number of endangered species (Collar *et al*. 1994, Collins 1990, Mittermeier *et al.* 1999a). Second-growth and mixed types of forests are also key habitats for many species, and clearing these forests has threatened thousands of plants and animals.

Page 1 (Gradual Destruction)
Page 2 (Paper)
Page 3 (Tropical Forest)
Page 4 (Logging)
Page 5 (Threatened Animals)

Forests' Retreat: Page 1

Forest destruction is often gradual, a whittling away by settlers and farmers who destroy portions of forest to grow crops using fislash-and-burn,fl in which trees are cut, set afire, and the ashes are used as fertilizer for subsistence agriculture. In tropical forests, the thin soil is fertile for only a few years, and farmers move on to clear more forests. When human populations are very small, as in the case of the native peoples of many tropical forests, their effects are not severe or permanent, as the forest grows back. Non-indigenous people, however, often remove forest cover permanently**.** They do not think of the forest as a source of life, providing food and protection, as native peoples do. The entire center of the 1,000-mile-long island of Madagascar, once a verdant paradise with giant trees and teeming with wildlife, is now a moonscape as a result of such misuse of the land. Millions of rural people in developing countries now depend on wood cut in local forests for fuel. This has been another major factor in deforestation because of the growth of human populations spreading into new regions, cutting trees and clearing away vegetation.

In the Caribbean, Europe, eastern North America, North Africa and West Asia, most of the original forest cover was destroyed prior to modern times. These forests will not return once cut, nor will their diversity. The ecology and diversity of the forests that once covered much of Europe and the eastern United States will remain unknown because they were cut prior to any biological studies. We have only descriptions of giant trees and the wildlife that inhabited these forests. In the temperate rainforests of the Pacific Northwest, however, biologists are studying the last 5 percent that survives of these magnificent**,** old-growth forests. Working in the canopies hundreds of feet above the forest floor, they are making new discoveries about these ecosystems. They have learned that lichens colonize only the oldest forests and are key to fixing nitrogen (Moffett 1997), or converting this essential gas into compounds that can be used in forming life-sustaining amino acids and proteins (Franck and Brownstone 1992). One forestry student who climbed a 2,000-year-old Sequoia found cones growing only on the outer branches, which can remain on the tree for as long as two decades**;** a rich variety of lichens grow**s** on trunks and branches (Moffett 1997). Such discoveries illustrate the importance of preserving these ancient forests.

Only a little more than a century ago, rainforest and temperate old- growth forest covered millions of square miles in West Africa, Central and South America, Southeast Asia, Australia and the western United States. Early settlers, followed by commercial loggers and large-scale livestock and agricultural interests, permanently destroyed these complex ecosystems. In some areas, second-growth forest or shrub has replaced them. Only in Amazonia, Central Africa, Russia and northern Canada do large tracts of virgin forest remain, and these are now being logged by international corporations.

Forests' Retreat: Page 2

A major use of timber is newsprint. Every Sunday edition of *The New York Times* consumes 75,000 trees (Bohan *et al*. 1996). Each issue of *Audubon* magazine, published by the National Audubon Society bimonthly, consumes 1,500 trees to make the 150 tons of glossy paper used to print 500,000 copies, according to its own research (Webster 2001). The trees used in the making of this paper were cut after 12 years by a mechanical harvesting machine that periodically clearcuts and replants with only one type of tree, creating an unnatural monoculture (Webster 2001). To

remove the cellulose, chlorine is used, which releases .004 pounds of chlorine and chlorine gases into the air (Webster 2001), less than in the past but still an environmental threat. This organization, like many using large amounts of non-recycled paper, claims that the monocultures are teeming with wildlife (Webster 2001) and, by all appearances, does not consider other alternatives for the manufacture of its magazine. Other magazines, such as *National Geographic*, also use unrecycled, glossy paper. By contrast, The Nature Conservancy decided in the 1990s to abandon use of virgin paper for their magazine, even if it meant a less glossy finish, and now prints on recycled paper. Many other conservation organizations have followed suit.

Tropical woods are also used to manufacture paper. With conservation and recycling by consumers in North America, Europe and Japan, no tropical forest trees would need to be cut for paper. The majority of newspaper used in the United States, which is the world™s largest consumer of paper, is thrown into landfills or burned (Bohan *et al.* 1996). Many tree-based products, from shipping crates to plywood and paper, could be made from other materials, both non-wood and re-used wood. Corporations feed a market hungry for inexpensive raw material. The trees are sold for almost nothing by the countries of origin, resulting in high profit margins for logging companies.

Forests' Retreat: Page 3

In the year 1500, tropical forests covered continental and island areas totaling 5.5 million square miles (Collins 1990). Today, only a fraction of this extraordinarily rich ecosystem remains. The estimates of loss vary. Some scientists count only the acreage of untouched pristine rainforest in their estimates, while others include various types of tropical forests, second-growth and disturbed forests. Satellite images, combined with aerial photography and ground surveys, are giving an ever more detailed and accurate picture of the decline of these irreplaceable forests. One reference, *The Last Rainforests*, edited by Mark Collins (1990), calculated that in 1990, only 3.3 million square miles of tropical forest remained in the world. It estimated that about 54,000 square miles were being cleared worldwide every year (Collins 1990). This authority concluded that 50 percent of all tropical forests had been lost since 1900 (Collins 1990). In the disastrous decade of the 1990s, as much as half of the remaining tropical forests were cut or burned. Although estimates of loss vary, there is general agreement that dramatic losses occurred in many parts of the world during the 20th century.

This destruction is taking place at a catastrophic rate. According to Dr. Edward O. Wilson of Harvard University, an expert in biodiversity and tropical forests, the surviving tropical forests equal the lower 48 US states in area, and a region the size of Florida is disappearing each year. The Nature Conservancy (2000) estimates that 40 million acres of tropical forests disappear every year. Settlers in many tropical forests have traditionally practiced slash-and-burn. The soil is so thin that it becomes sterile after a few years of farming, and the farmers move on, cutting more forest. Such practices whittle away at forests, but when carried out only by small bands of natives, these cut-over acres tend to recover in time. In many areas, however, European settlers have cleared land in this manner and fertilized the soil, maintaining it as agricultural land or depleting it so severely that the forest can never grow back.

Forests' Retreat: Page 4

Cambodia's last expanses of tropical forest are being lost in a pattern typical of many countries. Intensive logging during the past 50 years has reduced forest cover in this country from 70 percent to only 35 percent (Mydans 1996b). In spite of a logging ban instituted in January 1996 and a ban on exporting logs set in place in April 1995, the country's two Prime Ministers signed secret concessions to sell off virtually all of Cambodia's remaining forests (Mydans 1996b). The ancient teak forests are being openly felled, with logs exported to neighboring countries for profits of $10 to $20 million per month and in spite of official pledges to stop this logging (Mydans 1996b).

Elephants are used to haul the logs across rough terrain, and many are abused with drugs to keep them working and overloaded, causing serious injuries or death. Some have been maimed or killed by stepping on land mines. Armed guards protect these loggers and sawmill operators; regional forestry officials, who oppose the cutting, are unequipped to confront them (Mydans 1996b). Already, siltation, erosion, flooding, and destruction of agricultural fields have resulted, and Cambodia's King Norodom Sihanouk, who appears helpless to stop this situation, commented, "If this deforestation does not stop, Cambodia will be, alas, a desert country in the 21st century" (Mydans 1996b).

Asian logging companies have now turned to the pristine forests of Belize, the only sizeable forests remaining in Central America. In 1997, the government of Belize sold logging rights to Atlantic Industries, a Malaysian company, for $60 an acre to clearcut in primary, old-growth rainforest**,** principally for mahogany (Hecker 1997). The company logged in areas outside the agreed-upon area and leveled large numbers of Sapodilla trees, the source of chicle that can be tapped sustainably (Hecker 1997). The deforestation of Central America has been most extreme in El Salvador, Nicaragua and Costa Rica (Collins 1990, Harcourt and Sayer 1996). Fires set by settlers and business interests creating plantations for palm oil and tree farms, burned out of control in the late 1990s in Borneo, Sumatra, Bolivia and Brazil, destroying many ancient forests, including some in national parks.

Secret agreements between various government leaders and international logging corporations or with friends and relatives, for logging rights over large sections of forest are commonplace in many countries. Indonesia and Malaysia, for example, encourage destructive clearcuts in which conservation is not a concern, and fast-paced logging is carried out because the agreements may be negated by a change in government officials (Yates 1992). The largest remaining rainforest in West Africa, a 2.5-million-acre swath in Liberia, is being logged by a Hong Kong timber company as a result of a large bribe paid to the brother of Charles Taylor, the newly elected President of the country (Farah 2001). Such bartering away of the world's greatest treasure-houses of biological diversity is a travesty that will adversely affect the Earth's stability and the lives of many generations of people in the future. Lost will be magnificent ecosystems containing plants and animals not even discovered.

Corporate logging has emerged as the major cause of tropical forest destruction, greater even than the losses to settlers and agriculture. This logging is carried on without international controls and with inadequate national controls. This industry grows each year, and the international trade in wood, pulp and paper is now worth about $100 billion per year, making timber the third most valuable natural resource (Bohan *et al*. 1996). Of this total, a large percentage is timber from tropical forests. By the mid-1990s, scientists estimated that some 80 percent of Southeast Asia's--and a similar percentage of West African and Madagascar's--forests had been destroyed. An in-depth study of corporate logging by the Environmental Investigation Agency (EIA) estimated total sales of one of the largest corporations, Mitsubishi, at $5.3 billion in 1995, controlling a total land area of 9 million hectares (22.2 million acres) (Bohan *et al*. 1996). Mitsubishi's plywood mill in the Brazilian Amazon consumes 130,000 cubic meters of logs every year through the intensive and unregulated harvest of virola trees (Bohan *et al*. 1996). About 75 percent of all tropical forest trees is turned into plywood for disposable packing crates, construction and furniture, according to the Rainforest Action Network (RAN) of San Francisco, California (RAN 1993). The United States alone imports several hundred million pallets of tropical hardwood each year and throws them away after a single use (Revkin 1997).

Forests' Retreat: Page 5

The promotion of a commercial approach to old-growth tropical rainforests, even "sustainable yield," is based on fragmentary and inadequate knowledge of these ecosystems. It is not known with certainty that their trees can be harvested without harm. Sustained yield forestry concerns prevention of the extinction of various tree species by controlling harvest and, to a lesser extent, protecting of watershed and soil, but not necessarily ecosystem protection. Maintaining the complex web of plants and animals that form a forest should be the prime consideration in conservation. To this end, protection from harm is the logical approach until these ecosystems are properly

understood. Their ecological value will only be measurable as knowledge about their functioning and their role in the world's climate are explored in the future. In economic terms, they have great potential as tourist attractions, and the new videocam Internet business, as described in the Focus on Indonesia section below, will likely far outproduce short-term income from timber or conversion to agriculture.

An indication of the effects of this destruction is the fact that 76 percent of the 1,186 birds in higher categories of threat, or 902 species, are forest•dwellers, according to *Threatened Birds of the World*, a comprehensive report by BirdLife International, which examines bird status for the *Red Lists of Threatened Species* published by the International Union for the Conservation of Nature (IUCN) (BI 2000). All these birds are in danger of extinction. Some, such as the 182 Critical species, are in imminent danger of becoming extinct. Of the 902 forest birds, 93 percent are native to tropical forests; of these, 41 percent are found in lowland forests and 36 percent in montane moist forests, such as cloud forests (BI 2000). Three-fourths of threatened forest birds are dependent on a particular type of forest, and almost half require near-pristine habitat, with little or no disturbance, or habitat degradation (BI 2000). Only 3 percent of threatened forest birds can tolerate habitat modification. Unsustainable selective logging affects 367 forest bird species, while other threats include clearing forests for small farms (24 percent), tree plantations, clearcutting forest, livestock grazing, cutting trees for firewood, mining in forests and human settlements (BI 2000). An additional 727 bird species are classified as Near-threatened or close to qualifying as Threatened.

Likewise, forests are the major habitat for threatened mammals. The IUCN assigned habitat types to 515 (46 percent) of threatened mammals, finding that about 75 percent inhabited tropical rainforest; of these species, 35 percent in lowland and about 22 percent in montane (Hilton-Taylor 2000). (Some mammals may occupy more than one habitat). Tropical dry forest accounts for another 15 percent; tropical degraded forest, 4 percent; and tropical savannah woodland about 5 percent of threatened mammal habitats. By comparison, temperate broadleaf forest is the habitat for some 4 percent; and coniferous forests, 5 percent of threatened mammals (Hilton-Taylor 2000). The vast majority of threatened frogs and toads are also native to tropical forests.

Many species of tropical trees have been driven to extinction by habitat destruction and the exotic wood trade. The majority of Caribbean islands, which were covered in tropical rainforests when Europeans first saw them in the late 15th century, are now barren. A species of mahogany native to the Caribbean (*Swietenia mahogani*) has been so heavily exploited that no unstunted specimen remains. Elsewhere, once common species of forest plants and animals have been eliminated or endangered. Where habitats were limited on islands such as Hawaii and Mauritius, fragrant sandalwoods and other trees were cleared, and few--if any--specimens remain of the trees that once made up these forests.

Forests' Retreat: Page 6

The Rainforest Action Network has documented that 140,000 mahogany trees are being logged annually, with each tree worth about $1,500 wholesale in the United States, where most are marketed (Line 1996). RAN states that most of the mahogany trees in trade have been illegally logged from parks, conservation areas or other protected lands, causing ecological damage on a large scale.

Mahogany takes 40 years to reach harvestable size, and the majority of this wood that is traded internationally comes from wild harvested trees. Many tropical species have reached commercial extinction, and Honduran Mahogany, which grows to 130 feet with a massive canopy, is the major target of the logging industry in Central America. By having a market for mahogany, especially a lucrative one, loggers seek out these trees, even in protected national parks. Once in commerce, distinguishing legal from illegal becomes impossible.

Trees that are commercially valuable are often the very ones most important to wildlife for food sources or shelter.

The largest and oldest trees produce the greatest profits and are the first to be cut. These trees provide nest holes for owls, toucans, hornbills, parrots, tiny monkeys, lorises and galagos, rare lemurs, and countless other wildlife species. Many species of wildlife use tree holes for shelter year-round. Although some birds, such as woodpeckers, can excavate nest holes, the majority of animals who shelter and nest in tree holes depend on natural cavities. These holes form when tree limbs fall off or from rotting within tree trunks. Research on wild macaws has determined that a lack of trees with nest holes plays a major role in limiting their populations. Macaws nest only in large cavities very high, usually 100 feet or more, in tall tropical trees. Only the oldest and largest trees have tree holes for the more sizeable animals, such as hornbills, macaws and families of small primates who den together.

The Harpy Eagle (*Harpia harpyja*), the world's largest eagle, is endangered in its neotropical rainforests. Its range once extended unbroken from southern Mexico through the Amazon but today it is rare or absent throughout the remaining forests. A major factor in its decline is logging of the tall, old trees it requires for nesting. These eagles need a high vantage point overlooking the treetops to spot prey and to prevent predation on their nests. Harpy Eagle chicks have a long period of fledging, and prior to their independence, they must strengthen their leg and wing muscles. Eagle parents always make their massive nests near the top of giant trees with wide branches near the nest where the chicks can exercise by running across the branches, flapping their wings. As the strongest avian predators in these forests, they must be able to kill animals as large as sloths and carry them off in their talons. Loggers spot these giant trees rising over the forest canopy and cut them for the enormous amount of wood they contain. In much of Central America, selective logging and clearcutting have destroyed many of the former haunts of this magnificent bird.

Dead trees still standing are also prime wildlife nests and shelters, but because they are considered fire hazards, they are cut routinely. Hollow limbs and fallen logs are used by many types of animals for shelter or nesting, and these are usually trimmed off by loggers. Rotting tree trunks and cavities in both standing and fallen trees support entire communities of insects and invertebrates, upon which many vertebrates depend for food, and which contribute to the forest's health.

Modern loggers use mechanized tools and machines to clearcut forests. Chainsaws can cut through the massive trunk of a thousand-year-old tree in minutes. For smaller trees, saws mounted on trucks slice their trunks like matchsticks, and machines lift the trunks onto logging trucks for transport, trimming off side limbs in the process. Every tree in a forest, ancient or young, commercially valuable or cut only to be discarded, is logged. Forests covering 1,000 square kilometers have been completely denuded in a single clearcut. Huge processing trucks sweep through the forests, creating deep ruts in the forest floor. Roads are bulldozed for this logging, opening up forests, causing erosion to soils and flattening fragile plants. Baby birds, squirrels, bats and tiny primates in tree holes are killed as their homes are sent crashing to the ground and dragged along the forest floor.

Forests' Retreat: Page 7

Kitt Chubb, a Canadian wildlife rescuer, recounted the trauma that one family of owls endured as a result of a mechanical logging operation. Tiny Screech Owl (*Otus asia*) chicks, still downy and being fed in their treehole nest by the parents, suddenly found themselves slammed to the ground when the tree was cut. A giant logskidder machine roared through the woods gathering up the cut trees, including the one containing the owl chicks (Chubb 1995). The machine proceeded through the woods, bouncing and violently rocking over rocks and ruts. This cacophony must have terrified the owl chicks. Finally, the driver dumped the trees with a crash onto a pasture (Chubb 1995). Soon after, an employee with a chain saw began to cut up the trunks, and as he cut into a big knothole, he jerked the saw back when he saw three fuzzy grey owl chicks with their eyes closed tight (Chubb 1995). Amazingly, they had not been injured or killed after being knocked and bounced about. The loggers decided to save the little Screech Owls, bringing them to Chubb's wildlife rescue center. She placed them in a wooden box and returned with the box the next

day to the spot where their nest tree had stood. The forest where the owls had lived had been obliterated, and not a single tree remained. Finding a hollow beech stump in the clearcut not too far away, she and fellow rescuers placed the box in the stump, covering the top with leafy branches for shade, hoping the parents would return to feed the chicks (Chubb 1995). The next day, Chubb was surprised to find a frog leg in the box with the chicks, left by a parent owl. The chicks were lively and vocalizing, and 10 days later, they were still healthy and ready to be banded (Chubb 1995). Unfortunately, few baby birds and other animals survive logging operations or are lucky enough to be rescued if found alive.

Even animals as large as bears are frequently killed when they den in large tree holes. If their cubs survive, they will die of starvation if not rescued. Numerous cases of logging operations orphaning or causing mothers to abandon bear cubs are documented each year. A National Geographic Society film, fiMother Bear Man,fl shown in 1998 on "National Geographic Explorer," told the story of three bear cubs found after logging operations and their long return to the wild under the care of a kind and experienced wildlife rehabilitator in New England. Turtles, rodents, snakes and ground birds sheltering in burrows can be crushed to death by heavy logging machines. The soil, no longer held in place by root systems, breaks loose when saturated by heavy rains. Severe erosion on hillsides can cause mud slides that swallow up houses and the forest below, leaving a virtual moonscape, devoid of life. On level areas, rain washes soil into streams and rivers, clogging them, which kills fish and other aquatic lifeforms. Beautiful tropical forests with 300 or more species of trees per acre, a typical diversity, and myriad species of birds, mammals, reptiles, amphibians and invertebrates inhabiting them, become denuded patches of bare soil interspersed with stumps and broken limbs after clearcutting.

Even in remote wildernesses, the heavy machines that are now used to harvest and transport trees create such havoc and noise that wildlife flees. Many species of rare primates and birds disappear from logged forests, unable to adapt to any logging activities. A recent study in Gabon found that selective logging operations so traumatized Chimpanzees (*Pan troglodytes*) that their population in one 2,000-square-mile reserve fell by 80 percent after logging, even though only 10 percent of the trees were cut (Stevens 1997a). Dr. Lee White, a biologist with the Wildlife Conservation Society in New York, who was studying these Chimpanzees, made the following observation when loggers were in the forest: "I had whole chimpanzee communities charging to about five meters and screaming at me, and that's very unusual behavior" (Stevens 1997a). They were observed in logging areas in extremely agitated states, drumming on trees and calling to each other. The tremendous noise and disturbance by large machines apparently caused them to flee into the territory of neighboring Chimpanzees, where they fought to the death (Stevens 1997a). Both the Chimpanzee and Bonobo, or Pygmy Chimpanzee (*Pan paniscus*), are endangered species, and the latter is unlikely to survive much longer in the wild as a result of logging. Its tiny population inhabits a restricted portion of forest in the Democratic Republic of the Congo, the former Zaire. Both are also killed in large numbers for meat markets by loggers and hunters, who use logging roads to enter forests. The traumatized orphaned young are sold as pets and to others who exploit them commercially.

Forests' Retreat: Page 8

Many of the last old-growth forests have been cut for throwaway products such as shipping crates, concrete forms, plywood, chopsticks and newsprint. Virgin rainforests in southeast Asia, Australia, Alaska, Russia and British Columbia are being logged to supply the enormous demand for such products, destroying entire ecosystems in the process. The United States and Japan have played major roles in the logging and trading of lumber at extremely low prices for industrial uses (Yates 1992). When one country's forests are stripped, loggers move on to another. In this way, the great Philippine forests of Pliocene trees and Central American forests were cut in the mid-20th century, followed by the teak forests of Thailand and the hardwoods of Indonesia and West Africa. These areas have lost 80 percent or more of their forest cover, and loggers have now moved on to Central Africa, Burma, Belize and Amazonian South America. Brazil's beautiful rosewood trees have already been logged to near extinction. The World

Conservation Monitoring Centre of Cambridge, UK, conducted a study on commercial logging and found that 304 tree species from Asia and Africa were threatened with extinction by trade (Bohan *et al.* 1996). Fifteen species of commercially logged trees are listed by the Convention on International Trade in Endangered Species (CITES) in the most endangered category.

In response to criticism about clearcutting, some logging companies and conservation organizations endorse selective cutting, or cutting only certain species of trees or trees of a certain age. Yet such logging is also destructive. One United Nations (UN) Food and Agriculture Organization (FAO) study found that selective cutting destroyed as much as 70 percent of forest cover when conducted totally irresponsibly and, on average, destroyed 30 to 40 percent of the trees (Bohan *et al*. 1996). Destruction of non-target trees occurs with the construction of logging roads and use of heavy equipment to extract trees; when tree canopies and vines entangle one another, many trees are brought down, although only one may be cut. A study in French Guiana found that an average of 57 trees are killed for every tree extracted by selective logging (Bohan *et al*. 1996). Research on logging in Sarawak, a Malaysian state on Borneo, found that of every 26 old-growth trees cut, 33 others were destroyed or damaged, and canopies were broken, isolating animals who will not cross open spaces (Yates 1992). The thin tropical soil was also compacted and exposed, preventing natural regeneration of the forest (Yates 1992).

Many logging companies claim that by cutting mature trees selectively on 30- to 70-year rotations, they are conserving forests (Collins 1990). By definition, no tree older than 70 years can exist in such a forest. Such logging will end in destruction of the ancient and diverse forests, with trees 1,000 or more years old harboring a wealth of species that can only grow and prosper in old-growth forests. The more diverse a forest, the more stable ecologically, and logging tends to impoverish diversity by selectively removing certain commercially valuable species.

Thousands--and perhaps millions--of species depend on primary, virgin forests and cannot adjust to second-growth or logged forests. How many, and which species they are, however, is only partially known. Even scientists specializing in forest wildlife have not determined all the species that fall into this category, especially in complex tropical forest ecosystems. Unfortunately, this knowledge is often acquired too late, after logging has taken place and endemic species have disappeared. Logging operations are proceeding with such speed, and the scientists chronicling the damage are so few in number, that in terms of threats to plants and wildlife, only the tip of the iceberg is being documented.

Forests' Retreat: Page 9

Until the 1970s, no one knew what the effects of clearcutting forests would be on various species of rainforest wildlife. The US government's Smithsonian Institution, with ornithologist Dr. Thomas Lovejoy supervising, conducted the first scientific studies of the effects of forest destruction in the Amazon on a wide range of wildlife. Blocks of interior forest of various sizes were inventoried by teams of biologists with mist nets and live animal traps. After each inventory was completed, the blocks were isolated by clearcutting the forests surrounding them. Then, after a period, they were inventoried again to discover the effects of clearcutting on the wildlife in the newly isolated forest patches. This type of research aims to discover how large reserves must be to preserve the diversity of ecosystems.

The results of Lovejoy's research in Amazonian primary forest indicated that small reserves of 2.5 acres or less lose a large percentage of their wildlife, and the larger the reserve, the fewer the number of species that disappear (Lovejoy *et al.* 1984). Certain species are dependent on large areas of primary, old-growth forest and are quick to disappear as soon as forests are disturbed or fragmented. Bird populations tended to decline in most reserve sizes, and species composition changed. In the smallest plot, 39 species of birds dwindled to 18 species after three years, and in the larger plot of 25 acres, 48 species declined to 38 (Lovejoy *et al.* 1984). The understory species were censused, as

opposed to the canopy birds which seem less vulnerable to fragmentation of forest. Ecological dependencies caused some extinctions. For example, army ants thrive in large areas but disappear from smaller ones, and birds that feed on these ants, such as antbirds which are diverse and numerous in primary forests, disappeared within a short period from smaller plots (Lovejoy *et al*. 1984).

In another chain reaction, the White-lipped Peccary (*Tayassu albirostris*) proved to be a keystone forest species. It digs small waterholes to wallow in when ponds dry up, providing habitat for other wildlife. Peccaries travel in large groups seeking their diet of fruits, especially palm fruits, and act as seed dispersers. The key to their survival is territory size: a herd of 100 animals requires a territory of 97 square miles (Fragoso and Silvius 1995). They disappear from smaller forests causing the local extinction of frogs, who lay their eggs in these waterholes. In the Amazon study, four species of frogs disappeared from areas where peccaries had insufficient habitat to survive (Lovejoy *et al*. 1984).

Many other mammals are affected by forest fragmentation. Twenty species of mammals occupied a large, undisturbed forest plot, while only five were left in an isolated 25-acre-forest; a mere three mammal species remained in a 2.5-acre-forest (Lovejoy *et al*. 1984).

Theoretically, extinctions also can be caused when species have limited distributions which are destroyed by logging. A number of birds and mammals, including several newly discovered marmoset species in the upper Amazon forests, inhabit extremely restricted ranges of only a few square miles. Some species of primates will refuse to cross a road, such as a logging road, or an open clearing. Should a road be built in the middle of their tiny ranges, they would face extinction. Since tropical forests have not been thoroughly inventoried, the endemic species at risk most probably number in the tens of thousands.

Butterflies that live only in deep, virgin rainforest are so intolerant of fragmented forest that they disappear from areas less than 250 acres and, even there, survive only in the central core area (Laurance and Bierregaard 1997, Lovejoy *et al.* 1984). Forest butterflies, which exist in amazing diversity, are highly sensitive to the disappearance of their host plants, upon which they lay their eggs, and thrive in greatest number when vegetation is highly diverse. Some cannot tolerate the penetration of light into forests, and others require such large territories to feed that they disappear from small reserves, according to research by Keith Brown and Roger Hutchings (Laurance and Bierregaard 1997).

In small forest blocks, trees on the forest edge become vulnerable to the effects of wind and fire, fall in far greater numbers than those in the center and succumb to fires that spread from neighboring grasslands. Fires consumed large areas of rainforest in the Amazon during the late 1990s as a result of fragmentation. This was the first record of rainforest fires in this region. Storms blow down trees adjacent to the edges of fragmented forests and, over a period, will destroy the inner primary forest (Lovejoy *et al.* 1984).

Research on forest fragmentation is now taking place in Africa, Asia, Australia, the Indian Ocean islands and elsewhere in the world. Numerous scientific papers on the subject were gathered in a book entitled *Tropical Forest Remnants. Ecology, Management, and Conservation of Fragmented Communities* (Laurance and Bierregaard 1997). Many of these studies paint a grim picture of the effects of forest fragmentation on biodiversity.

Bats are important forest pollinators but are extremely vulnerable to extinction. They are rarely protected and often persecuted. The valuable Durian fruit of Asia is one such plant pollinated by a declining species of rainforest bat. Other food plants pollinated by bats include wild bananas, breadfruit, mangoes, guavas, avocados, almonds, cashews and cloves, according to Bat Conservation International, which is dedicated to changing the negative image of bats and preserving wild populations (see Organizations list for address).

Forests' Retreat: Page 10

Throughout the world, biologically diverse natural forests are being replaced with tree farms of fast-growing pine or eucalyptus. In Japan, cedar is planted over millions of acres for harvesting. The goal of these farms is to replace old-growth forests that take hundreds of years to mature with trees that can be harvested in 30 to 50 years. Large amounts of herbicides and pesticides are applied to prevent the growth of "undesirable" plants and to control insects. These tree farms have contaminated water tables, destroyed natural diversity, and eliminated countless life forms crucial to maintaining the ecological balance of the planet. Moreover, many are now failing even in their goal of producing fast-growing, healthy trees because of a lack of understanding of ecological systems and natural forest functioning. Tree farms are frequently swept by disease and, in the case of Japan's cedar plantations, which cover 10 million acres, shallow roots have resulted in trees blown over in windstorms and landslides after heavy rains. A healthy forest has many species of trees. This diversity discourages insect pests, which tend to specialize in individual species, from spreading and sweeping through the forest, killing all the trees. The variety of trees in a natural forest also means that many are deep-rooted or have root mats that anchor the soil from erosion.

An added environmental threat posed by tree farms is the use of genetically engineered seedlings, whose effects on ecosystems are not yet known. By transplanting genes from other species of trees--and even animals-- into these unnatural trees, the possibility that their seeds could spread to the wild and contaminate natural trees and plants is very real.

Major disruptions in pollination occur in fragmented forests. Natural tropical forests, with hundreds or even thousands of species of trees, have evolved complex systems of reproduction. Because other trees of the same species might be miles away, trees send their pollen far and wide. Insect pollinators travel great distances to find trees of the same species. Biologists have found that even in selectively logged forests, trees were not being pollinated naturally because others of their kind were removed or became too distant; some species self-pollinated, causing in-breeding, while others simply died out (Yoon 1995b). These biologists concluded, "Even the forests that appear the healthiest but are being selectively logged or otherwise thinned may be endangered in the long run by an increase in less desirable inbred seed" (Yoon 1995). Inbred stock usually loses vigor and ability to reproduce over the long run. This is an ominous finding considering that many conservation organizations and international logging companies have endorsed certain "sustainable" logging programs, urging the public to purchase products identified as such. Moreover, many of these ancient trees tower 200 or more feet, with wide buttresses at ground level to anchor them in the thin tropical soil. Such trees may have stood on the forest floor for 1,000 years and are living monuments, treasures to be preserved, not raw material for packing cartons, furniture or paper pulp.

Preserving Forests

A 10-year mapping project by the World Conservation Monitoring Centre ending in 1996 found that only about 6 percent of the world's remaining forests are protected against logging and development. Because of the rate of destruction and the potential loss of biological diversity, this is an extremely critical situation.

Page 1 (Recycling and Substitutions)
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Preserving Forests: Page 1

Much of the logging in the world is a result of markets provided in the United States, Japan and Europe for wood and wood products. Because paper pulp is cheap, there is little effort to find substitutes or even to recycle the millions of tons of paper thrown into landfills each year. The use of trees for making paper is government-subsidized, encouraging waste and destruction of forests. Tree farms have failed to meet the enormous demand for paper. Financial incentives to recycle or use other materials should be made by consuming countries. Finding substitutes for lumber and raw material for paper will be crucial in protecting entire forests. The United States imports 800 million pounds of paper from Brazil every year, to the detriment of that country's forests. In spite of computers and Internet communications, total amounts of paper used in the United States have not decreased; 4.3 million tons of paper are used in US offices alone each year, and millions more tons are used in newsprint, magazines and other paper products. Because of a lack of economic incentive, only a small portion of this paper is being recycled into new paper. In fact, studies of landfills have shown that 40 percent of material in these dumps consists of unrecycled newspapers.

Innovative approaches are needed to encourage recycling and to end subsidies and the importation of wood chips and newsprint from forests around the world. Some of the alternatives to paper made from wood are already in use. Thousands of years ago, Egyptians produced paper from papyrus reeds, and rice is still used to make paper in parts of East Asia. Cotton and flax are the raw materials of fine quality paper used for currency and other purposes.

Many other plant species are now seen as substitutes for wood pulp in making paper. In *A Wealth of Wild Species, Storehouse for Human Welfare*, Norman Myers (1983) mentions one of these, a plant called kenaf, that is a distant relative of cotton and okra. This plant has been cultivated for centuries in Asia for making burlap bags. A fast-growing, reed-like plant, kenaf shows great potential in the manufacture of paper. Its straight, slender stem has no side-stems, nor does it produce the kind of resins that must be eliminated when wood pulp is processed for paper. Planted like corn, it is ready for harvesting in four months and produces five times more pulp per acre than a pine tree plantation (Myers 1983). In research conducted by the US Department of Agriculture, kenaf has proven an excellent substitute for paper in newspapers and even bank notes (Myers 1983). A few kenaf farms have been established without government sponsorship in Texas and other southern states, and already many organizations are printing newsletters using kenaf instead of wood-based paper. Processing kenaf does not involve the serious water pollution caused when cellulose is removed from wood and pulp is bleached with chlorine. Air pollution from wood pulp processing plants has been injurious to human health (Verhovek 2000).

Earth Island Institute of San Francisco, California, has published a report, *Forest Friendly Paper Guide*, giving more information on kenaf and other non-tree substitutes for paper, including a new paper product by Arboken of Canada that is made from wheat straw, recycled corrugated cardboard and calcium carbonate filler. A publication called *Guide to Environmentally Sound Papers*, issued by an organization called Conservatree, lists more than 400 types of "green" paper. Among these are recycled, kenaf-based, hemp, sugarbeet and corn, grass and crop waste paper. (These can be obtained from Earth Island Institute. See the list of organizations in this book for the address.)

Preserving Forests: Page 2

Most homes are constructed of wood. An average of 40 to 50 trees are needed to build a 2,000-square-foot

wood-framed house (Bielski 1996). Building with stronger materials, such as steel, concrete, brick and stone, would spare millions of trees. Moreover, these materials are not vulnerable to infestations by termites, which destroy entire foundations and frameworks of buildings made of wood. To control these insects, pest control companies apply large quantities of extremely toxic pesticides that can leach into the soil and water table, killing wildlife, and pose hazards to the occupants of the house. The Institute of Ecolonomics in Ridgeway, Colorado, reports that a new tree-free "wood" has been developed for use as building material. Called BioComp, it contains half recycled plastic and half agricultural residue and, according to the Institute, is twice as strong as Douglas Fir, termite-proof, impervious to water, and can be made fire retardant. BioComp resembles wood and is easily molded, sawed and nailed. Some alternatives to wood are also less expensive. Steel is being used in New England homes for major support beams with a metal roof for less money than the same home would cost made of wood (Hotton 2001).

The Wood Reduction Clearinghouse has been formed in San Francisco to address the failure of considering consumption as a driving force in deforestation (Bielski 1996). A group of leading environmentalists issued a statement in 1995 calling for a 75 percent reduction in wood and paper use by 2025, and strategies for eliminating the need for wood altogether are being explored (Bielski 1996). The use of timber for shipping crates and concrete molds--especially tropical hardwoods--should be phased out and substitutes, such as plastics, phased in that would be more economical because they could be reused. Some stores are already using substitutes for the millions of cardboard cartons used to ship goods.

Preserving Forests: Page 3

At the 1992 "Earth Summit" in Rio de Janeiro, Brazil, convened by the United Nations Conference on Environment and Development, world leaders agreed on the importance of slowing the rate of global forest destruction. Conservationists have pressed for a new, legally binding Global Forest Agreement to conserve and manage the world's forests. In spite of the urgent need for such an international treaty, no agreement has been reached in the intervening years. Numerous meetings and conferences between nations have failed to draft a policy that would curtail the uncontrolled commercial logging that is ravaging forests around the world.

Several organizations, including the Environmental Investigation Agency (EIA), headquartered in London, and the World Resources Institute (WRI) of Washington, DC, have issued reports that chronicle the damage being done and the need for such a treaty. EIA's report, *Corporate Power, Corruption & The Destruction of the World's Forests, The Case for a New Global Forest Agreement*, argues for the need for international agreements to control commercial logging (Bohan et al. 1996). This report gives detailed information on the companies doing the most environmental damage to the world's forests and the methods used by these corporations to bribe and otherwise corrupt the leaders of poor nations to obtain logging contracts. Other organizations, such as the Rainforest Action Network, agree that international logging corporations must be regulated. This $100-billion-a-year trade operates with generous tax breaks from the countries where companies are based and the granting of logging concessions that often cover millions of acres through special arrangements made behind closed doors with government officials (Bohan *et al.* 1996). Logging concessions almost always ignore or overrule strict legislation already existing in many countries protecting the environment and wildlife, including endangered species (Bohan *et al.* 1996).

At present, cutting of forests is "regulated" only by the timber industry itself through the Tropical Timber Agreement, signed in 1983 by various international lumber companies. This agreement does not protect wildlife and the environment. In spite of renegotiation in the mid-1990s, the agreement still does not address ecological concerns or species preservation. Pressure from multi-national companies, primarily Japanese, to supply this lucrative market have overwhelmed the voices of conservationists throughout the world.

Logging in Central Africa is in the process of destroying the once vast and unspoiled forests. A conference in 1999

was convened by the World Wildlife Fund (WWF) to reach an agreement about the fate of these large tracts of tropical rainforest in Africa, located in Cameroon, Central African Republic, Gabon, the new Democratic Republic of the Congo, Equatorial Guinea and the Congo. In this region, 40,000 square kilometers of forest are being destroyed a year, endangering hundreds of wildlife species and opening up the forest to a devastating trade in bushmeat. Prince Philip, in speaking on behalf of WWF, stated that the organization hoped to protect 10 percent of this vast forest, an area too small to prevent extinctions and great biodiversity loss. The Democratic Republic of the Congo, which is in a state of political chaos, did not attend the conference, and no pact was signed.

Preserving Forests: Page 4

The forests of the Democratic Republic of the Congo are among the wildest and least explored in the world, but this wilderness is being invaded by loggers and meat hunters. Michael Fay, a biologist with the Wildlife Conservation Society in New York, has been on a mission to cross this vast area on foot, accompanied by some natives and correspondents, describing the amazing sights along the way. He is trying to draw attention to this region and the urgency of saving it while most of it is still in pristine condition. He has already succeeded in having a sizeable national park established. His trek is dangerous, with poisonous snakes, leeches, tropical diseases and other threats, but he is a dedicated conservationist and scoffs at the dangers. The National Geographic Society is helping to sponsor his trip and publishes regular articles in their magazine on his progress, and their website gives more information. Several short films have also been made for the National Geographic fiExplorerfl program. His mission is extremely important and has the potential of preserving entire ecosystems of threatened animals and plants.

A growing awareness of the problem, along with creative solutions, give hope that in at least some parts of the world, large tracts of tropical forests and their wildlife will be spared. Two enormous parks were established in Suriname and Bolivia in the 1990s, mainly as a result of the work of Conservation International, a US organization that successfully convinced the governments of these countries that such protection will be far more beneficial for the country than short-term exploitation and forest clearance. Other organizations are working effectively in central Africa, Peru, Brazil, Burma, Laos, Vietnam, and the Philippines to protect these species-rich forests.

New approaches to deriving funds from forests without logging and destroying diversity include regulated extraction of non-wood products, such as seeds, fruits and plants, for food and medicinal purposes. Ecotourism is one of the most lucrative and growing industries in the world, with revenues in the billions of dollars and rising.

Old-growth forests are being cut not because they provide raw material that cannot be found elsewhere, but because they provide a high profit margin to European, North American and Asian logging companies. Decisions made about the fate of these forests, upon which the survival of so many species depends, are not being made by the people where logging takes place, nor by conservationists. These precious and irreplaceable resources, habitat of the majority of the world's threatened species, are being sold to logging companies for pittances. The United Nations has recently endorsed the concept that forest diversity must be maintained, joining the ranks of many other international organizations. In time, society may learn to preserve these storehouses of evolution with the same zeal that great works of art are protected.

Preserving Forests: Page 5

One project has greatly improved the standard of living for villagers in India, while taking steps toward protecting the forest habitat of the highly endangered Bengal Tiger. Many thousands of residents were forced to move when Ranthambhore National Park was established decades ago, causing much resentment. At first, they were banned from

gathering firewood and grazing livestock within the park. This had an extremely positive effect on the forests, which regenerated, and Tigers, deer and other wildlife prospered. Gradually, however, park authorities became more tolerant of the incursions of local people and their livestock into the forests. During the 1980s, large areas became deforested, and poaching endangered Tigers and deer within the park.

To reverse this trend and preserve the habitat of this park's wildlife, a Tiger conservationist and author, Valmik Thapar, established the Ranthambhore Foundation. This Foundation sponsored a nursery which propagated 500,000 tree seedlings, employing villagers to replant the national park. It set up a farm with domestic buffalo which had been bred with milk cows and kept in stalls and enclosures away from the forests. These animals yield far more milk than the emaciated Indian cows overgrazing the forests; fuel for cooking and heating is provided by a bio-gas plant producing methane from the buffalo's dung; a new crafts industry employs women in the village (Ward and Ward 1993). In the first four years of the project, 6,000 school children from local areas were taken into Ranthambhore National Park for education programs (Currey 1996).

A Cable News Network (CNN) reporter, Gary Streiker, visited one of these farms outside Ranthambhore National Park in mid-1997. The villagers were economically better off and appreciated having the bio-gas fuel, which saved them the effort of scouring the landscape for firewood, often a full-day's activity. This allowed them to devote time to crafts and other small businesses. Unfortunately, some of the other villagers around the park were still gathering wood, denuding the park. These age-old customs will be difficult to change. Eco-development and conservation projects in 60 villages surrounding Ranthambhore National Park have been launched. Conservation education on the importance of saving the forests will help to change attitudes and protect the park's wildlife and trees. This will bring tourists and new sources of income.

Preserving Forests: Page 6

Several remarkable successes have proved a positive contrast to the otherwise gloomy trends of forest destruction. In South America, large expanses of undisturbed tropical forest remain, but they are fast disappearing. The Amazon Basin and its forests once covered 2.3 million square miles, comprising three•fourths of the world's tropical forests, but forest clearing has destroyed some 20 percent of the original forests and damaged far more. Amazonian forests contain 14,000 endemic species of plants (Harcourt and Sayer 1996).

Parque Nacional Madidi, Bolivia's newest national park, covers 4.7 million acres, protecting a variety of threatened habitats and species. Avian diversity for this park is estimated at 1,088 species of birds, or 11 percent of the world's birds, the highest in any protected area in the world; among these are many threatened species and others with small ranges (Remsen and Parker 1995). This park, watered by numerous rivers, borders eastern Peru and includes a variety of threatened environments. Humid lowland forests, grasslands and montane cloud forests are among these. Resident birds include the threatened Yellow-rumped Antwren (*Terenura sharpei*) and various species of tinamous and curassows (Remsen and Parker 1995). The latter birds are among the first species to disappear from areas as a result of hunting and habitat destruction. A proposed hydroelectric dam, which would drown large sections of rich lowland forests., is a major threat to the park. It may have been stopped as a result of publicity by *National Geographic* magazine, which featured a cover story in 1999 on the importance of saving this park. Public opinion and the potential tourist trade may compensate this country for lost revenues from the dam. An even larger park of 8.6 million acres along the border with Paraguay, the Kaa-Iya del Gran Chaco National Park, protects the most sizeable block of endangered dry tropical forest in the world (Seve 1996). These two parks will preserve more than 20,000 square miles, and native tribespeople will play a role in administering them (Seve 1996).

Another positive development is the trend in a growing number of countries to share the profits from national park fees with local people and involve them in the decision-making processes of managing the park and the local wildlife.

Madagascar has been successful at this, combining income from park fees with international grants to build schools, libraries and clinics for the local people. Patricia Wright, a primatologist, helped establish Ranomafana National Park to protect endangered lemurs as well as to protect the watershed from floods. In the recent past, deforestation carried out by local villagers had caused landslides that inundated their homes and caused water sources to dry up. They have become convinced of the importance of preserving the forests for their own survival. This new approach of educating local people on the benefits that would accrue to them as a result of conservation, as well as payment from park fees and profits from ecotourism, is the future of forest preservation.

Another trend that will prove important is the involvement of biologists studying wildlife with local people, learning from their observations and sharing the knowledge they uncover. Biologists in Madagascar who rediscovered an owl thought extinct, brought local students to see it and raised money for needed school supplies from birdwatchers who came from around the world to see the bird. This creates a positive impression on the local people and instills natural history curiosity and a realization of the uniqueness of their own wildlife. In the future, this may be expanded by showing them films about the natural world that surrounds them and opening up new worlds with books and publications about the subject. Very few people are aware of the endemic wildlife and plants in the environments in which they live, whether in the United States or the Cameroon. When people learn of the flora and fauna in their neighborhood that exists nowhere else, or is of biological importance, they are far more likely to protect it. Even in the United States, where Natural Heritage Programs chronicle the endemic and declining species of every state, the information has not always been made available to the public in the form of state publications or television or newspaper publicity that could have a major effect on whether forests and other habitats are protected.

A recent campaign to alert the public to the ecological advantages of choosing shade-grown, organic coffee has helped preserve rainforests in many parts of the world. A trend toward planting coffee plants in open fields rather than in the traditional way, as an understory to tall trees, has been devastating to tropical forests, home to both tropical birds and other animals, and to migratory birds from North America who spend the winter in Latin America and the Caribbean. Smithsonian biologists began this campaign in 1990 when they saw bird species decline with the planting of sun-grown coffee plants, and patented the logo "Bird Friendly" coffee. Such coffee is now commonly sold in health food and specialty stores and may become more popular as the public is educated about the problem. With the enormous popularity of coffee, this could make a major difference to birds and other wildlife.

North America™s Forests

The history of the destruction of all but 5 percent of the 850 million acres of old-growth forests in North America has been recounted in Chapter One. Second-growth forests now dominate the East, forests far different in species composition from the original virgin forests. The great chestnuts, elms and beeches are gone, and woodlands are now young, mixed pine and hardwood. Moreover, these forests are fragmented by roads and development. Only a few roadless areas remain. A few remnants of old-growth forests have been located in the East, primarily on steep slopes and areas that loggers found difficult to reach. In southern Maine, for example**,** a biologist recently located a stand of Black Gum trees, some 9 feet in circumference. One stump had 450 rings, and another, larger one was still thriving. It was estimated to be more than 500 years old, dating back to the time of Columbus. Unfortunately**,** this area is in the path of development (BG 2000). The Great Smoky Mountains National Park is a large block of forest totaling 500,000 acres in the southern Appalachians of eastern Tennessee and western North Carolina. This national park harbors some virgin old-growth and a wealth of rare native trees, plants and wildlife, including a great diversity of salamanders that inhabit its damp, mossy forest floors and fast-flowing streams. It sits atop a mountain range that is a meeting place of northern and southern species, an important area to the endangered Appalachian forest ecosystems and a primary migratory stopover and nesting area for threatened wood warblers and songbirds. This area recently has been designated an International Biosphere Preserve, and its diversity is being inventoried by a team of biologists and other earth scientists.

North America™s Forests: Page 1

Migratory songbirds of eastern forests have declined by at least 45 percent in the past 50 years. These dazzling migrants--wood warblers, vireos, tanagers, orioles, grosbeaks and thrushes--suffer from a variety of threats. Deforestation of tropical forests where many of these birds spend the winter has been a major factor. Species requiring mature, undisturbed forest have declined to the greatest degree, some losing up to 90 percent of their populations. Clearcut logging and fragmentation of their breeding forests by housing, malls, roads and other development have consumed millions of acres, displacing these songbirds. Many birds returning from tropical wintering grounds find their breeding forests destroyed or too small for successful breeding. A small patch of woods large enough for only one male songbird, surrounded by agriculture or development, will be abandoned if the male is unable to hear the songs of neighboring males (Line 1995). Many birds establish territories and maintain them by singing and challenging other males.

Another effect of forest fragmentation has been the proliferation of forest edge species that prey on songbirds and their eggs (Terborgh 1992). The Brown•headed Cowbird (*Molothus ater*), a parasitic species, was once seen only in grasslands. In the past, when huge herds of American Bison roamed the prairies of the Midwest, cowbirds accompanied them, laying their eggs in the nests of grassland birds, who raised them as their own. With the disappearance of the Bison, cowbirds entered the forests bordering agricultural and pasture land, laying their eggs in songbird nests. Some cowbirds now remain close to domestic cattle and fly into the nearest woodland to lay their eggs. Their eggs usually outnumber those of the host species, and the large chicks instinctively nudge the small songbird nestlings out of the nest. Because of the increase in forest openings, the net result of these losses has been a 90 percent decline in the number of songbirds recorded in the 1940s in many eastern forests (Terborgh 1992).

A campaign to declare a large section of the forests in northern New England a reserve began in the mid-1990s. To add urgency to the need for a national park in Maine, New Hampshire and Vermont, a new species of thrush, native only to this region, has been discovered. Once considered a subspecies of the wide-ranging Gray-cheeked Thrush (*Catharus minimus*), Bicknell's Thrush (*Catharus aliciae*) was found to be a totally distinct species in 1995, smaller and with a unique song. A bird of high altitude forests, it has already disappeared from its only nesting area in

Massachusetts, Mt. Greylock. The major breeding area for Bicknell's Thrushes is now Vermont, whose forests are under pressure from ski developments and proposed wind turbines. Additional populations of fewer than 3,000 birds inhabit neighboring southern Canada, but the traditional practice there of thinning forests renders these forests unsuitable. Its habitat of spruce-fir forests is dying out from acid rain and global warming (BI 2000). This threatened bird is also losing habitat in its West Indian wintering grounds, especially Hispaniola, where forests are being cleared (BI 2000).

Another member of the thrush family is declining toward extinction. Known for its melodious, fluted song, which many find more intricate and beautiful than the Nightingale's, the Wood Thrush (*Hylocichla mustelina*) has declined precipitously in recent years. Native to undisturbed hardwood and mixed forests in eastern North America, the Wood Thrush winters in Central America, from southern Mexico to southern Panama (Rappole *et al.* 1983). In August, these birds begin their southerly migration, often gathering in groups where the chorus of 50 or more Wood Thrushes may echo like a cantata in the tall trees. One research project studied these birds in one of their tropical wintering areas in the Tuxtla Mountain region of southern Veracruz, Mexico, on the Gulf of Mexico. Studies of this population of birds began in the mid-1970s when the wintering habitat consisted of primary rainforest. (Rappole *et al.* 1989). This forest has declined by 85 percent, a far higher percentage than elsewhere in Central America, leaving mere fragments of the once rich tropical rainforest (Rappole *et al.* 1989). In 1980, the two researchers returned to find that their 12-acre rainforest study plot had been converted to a patchwork of fields and forest fragments; less than 5 acres remained of the original forest (Terborgh 1989). Using radio•tracking and mist netting, researchers discovered that Wood Thrushes do not adapt to forests without tall trees, even as a wintering area, preferring undisturbed rainforest. Year after year the same individual birds returned to the same sites. In rainforest, they tended to survive the winter, while Wood Thrushes forced to winter in neighboring second-growth or disturbed forest had a high mortality rate from predators and other causes (Rappole *et al.* 1989).

Throughout their winter range, the forests that once harbored tens or perhaps hundreds of thousands of Wood Thrushes in Mexico and Central America have been turned to pastureland or tilled for agriculture. Between 50 and 70 percent have been destroyed (Collins 1990). Fewer and fewer Wood Thrushes return to nest in Eastern forests, even when they have not been fragmented or cleared (Terborgh 1989). Their nests have also been vulnerable to parasitism by Brown-headed Cowbirds (Terborgh 1989). In Illinois, for example, where Brown•headed Cowbird populations have skyrocketed in past decades, one study found that 29 of 30 Wood Thrush nests had been parasitized by Brown-headed Cowbirds, who laid eggs that crowded out those laid by the thrushes; the conclusion of the study: "Wood Thrushes are doing nothing but raising cowbirds" (Terborgh 1989). In the few areas where forests are unbroken and extensive, Wood Thrushes have been successful breeders (Robinson 1996).

Unfortunately, the combined effects of habitat destruction in both its breeding and wintering grounds, and parasitism of its nests by cowbirds, may result in the extinction of the Wood Thrush. A recent study in several Midwestern states found that birds from large stretches of forest that are holding their own may be having young that disperse to neighboring forest fragments, only to be crowded out by cowbirds (Robinson 1996). The melodic Wood Thrushes are disappearing throughout their range, along with many other beautiful songbirds.*

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*See Video section. fiOn a Wing and a Song,fl a Canadian Broadcasting Co. film produced in 1994 for The Nature of Things series, explores the decline in songbirds. Another excellent film on the same subject with a similar title, fiOn a Wing and a Prayer,fl produced in 1995 by Kurtis Productions and WTTW for the PBS series New Explorers, concentrates on the decline in breeding songbirds of Illinois and their migrations.

Other changes in environments also contribute to songbirds' declines. Recent research has found that high levels of noise from highways, airports and other man-made activities have interfered with the ability of birds to sing breeding songs and breed successfully. Birds that migrate to the Caribbean and Latin America suffer high mortality from

collisions with television and cellphone towers and tall buildings. For many years, one scientist at Chicago's Field Museum has collected migrating songbirds that died from flying into a single building near the museum**.** His collection now totals 20,000 birds. He estimates that total mortality from building collisions may be 60 million songbirds a year, an enormous loss.

A great concentration of breeding songbirds is found in Belt Woods, a 500-acre-forest near Bowie, Maryland. Trees that were growing when Columbus discovered America survive here. Perhaps the largest tract of old-growth forest in the region, it has a variety of habitats from swamp forest to dry hardwood stands. More than 40 species of migrant birds nest here, including Wood Thrushes, Rose-breasted Grosbeaks, Baltimore (Northern) Orioles, Scarlet Tanagers, Prairie Warblers and Ovenbirds. These are species that have disappeared from woodlands that have become fragmented, or contain few tall trees. This wealth of breeding birds underlines the importance of protecting old-growth forests. Privately owned, Belt Woods was willed by the late owner, William Seton Belts, to the Episcopal Church to be kept intact in perpetuity. The church, however, went to court in the 1990s to change the will to allow sale to developers, claiming that it had more important works to accomplish with the funds than saving the forest.

After conservationists had decided it was a hopeless cause, a local resident, Pam Cooper, decided to spearhead a rescue of these precious woodlands. By conducting publicity campaigns and fund-raising efforts, she and the Western Shore Conservancy raised money. A Maryland author and illustrator of children's books, Lynn Cherry, organized The Friends of the Woods to enlist children to help influence their parents and public opinion to place the preservation of this threatened woodland above that of sheer materialism and to champion the need to take on local conservation problems as a community. Her children's book, *Flute's Journey, the Life of a Wood Thrush*, chronicled the life of a Wood Thrush born in Belt Woods, its migration to Costa Rica and its uncertain future. The plight of Belt Woods was given national attention in April 1996 on a CBS program, "Sunday Morning," which may have been a crucial turning point in the preservation of this forest. Within months, an arrangement was finalized with conservation organizations that would turn Belt Woods into a reserve, ending the possibility that it would be sold to developers.

At a time when losses in the numbers of North America's beautiful songbirds may have become irreversible, scientific research is revealing that they play a crucial role in controlling insects in forests (Yoon 1994). In a controlled experiment, birds were excluded from a section of forest with netting cages that allowed insects to enter. It was found that trees and plants incurred twice the damage to foliage where birds were excluded (Yoon 1994). The study concludes that songbirds constitute a major and important form of natural pest management, superior to pesticides (Yoon 1994). Keeping songbirds from nesting in a stand of White Oaks, other researchers found that caterpillars consumed so much foliage that the trees grew significantly more slowly than White Oaks with nesting songbirds (Robinson 1996).

North America™s Forests: Page 2

It would probably shock most residents of suburban New York City to know that 150 years ago, wild Gray Wolves preyed on White•tailed Deer, Eastern Bison and Elk in the dense virgin forests now occupied by their neatly clipped green lawns, while overhead the flight of millions of Passenger Pigeons darkened the sky. The Eastern United States is undergoing a "Europeanization" in which natural forest is being lost to housing tracts, highways and urbanization. This sprawl consumes the second-growth forests, some of which had become excellent wildlife habitat, and the new residents often contaminate the water and soil with pesticides and herbicides to maintain green lawns. The natural world and its fauna and flora are fast disappearing.

Just as they are disappearing, discoveries about the medical potential of eastern forest trees are being made. Recently a fungus was discovered that is a missing link in the life cycle of a mold that produces the billion-dollar drug cyclosporin, used to prevent the rejection of transplanted organs (Yoon 1996). The forest of the Finger Lakes Land

Trust in Ithaca, New York, where Cornell University students found the fungus, has established the nation's first reserve set aside specifically for chemical prospecting outside the tropics (Yoon 1996).

Most of the Great Lakes region was originally covered in ancient pines. During the logging boom of the late 1800s, mills of one Great Lakes port alone, Ashland, Wisconsin, cut 500 million board feet of lumber a year (a board foot is equal to wood 1 foot square and 1 inch thick), enough for 50,000 houses (Johnson 1997). Timber barons shipped the lumber to rebuild Chicago after the great fire of 1871, and the logged-over area, covered in broken branches, stumps and discarded trees, ignited a series of fires, one of which killed 1,152 people in the town of Peshtigo, Wisconsin (Johnson 1997). These fires charred millions of acres, leaving a wasteland (Jonas 1993). By the end of the 19th century, the majority of these forests had been clearcut by commercial loggers (Jonas 1993). There remains a scarcity of timber, and in 1996 a treasure trove of 20,000 to 30,000 old-growth tree trunks was found by divers on the bottom of Lake Superior; they had sunk more than a century after being cut and floated to mills (Johnson 1997). Old-growth timber is extremely valuable. It has tight grain resulting from slow growth, unlike the grain in the trees grown on tree farms. These logs are worth many millions of dollars, and a company is bringing the logs to the surface, selling them for ten times the price of new wood (Johnson 1997). These are the last remnants of a once vast forest.

Early in the 20th century, Weyerhauser, the German timber magnate, having logged out the old growth of the Great Lakes area, turned to the forests of the Southeast. Forests dominated by Longleaf (*Pinus palustris*) and Shortleaf Pines (*Pinus echinata*), which have the world's greatest diversity of forest floor plants, dominated northern Florida west to Louisiana and north to central Georgia. Longleaf Pine forest once covered 90 million acres from Virginia to Texas. These forests also harbored Loblolly (*Pinus taeda*), Virginia (*Pinus virginiana*), Pond (*Pinus serotina*) and Pitch Pines (*Pinus rigida*), which grew in various types of soil and climatic conditions. Loggers decimated this ecosystem, cutting millions of board feet, and by the 1930s, these forests had been reduced to a fraction of their original extent. Today, only about 2 percent of the Longleaf Pine forests remain, making them the most endangered forest ecosystem in North America. For the most part, these forests have been replanted with other species, predominantly commercial tree farm monocultures.

Much of the remaining virgin pine forests of the Southeast lie on national forest land, and they are being heavily logged. On December 15, 1995, this destruction was fought by the Biodiversity Legal Foundation and the Alabama Wilderness Alliance, which filed suit in Federal District Court against the US Forest Service challenging the legality of the Forest Service decision to open a series of massive salvage timber sales of trees blown down by a hurricane, along with some healthy standing trees, on 15,000 acres of the Conecuh National Forest in Alabama. The Biodiversity Legal Foundation hired biologists and other experts, who testified that Forest Service management of the forest violated its own environmental regulation relating to logging near waterways and had planted non-native trees instead of the native species that are preferred by the Red•cockaded Woodpecker (*Dendrocopus borealis*), an endangered resident of this forest. This lawsuit was settled in favor of the conservation organizations.

North America™s Forests: Page 3

A victim of this logging, the Red-cockaded Woodpecker is a small bird marked in black and white and named for the male's tiny streak of red on each side of the nape. These birds have very specific habitat needs. For nesting trees they usually choose old-growth pines stricken with red heart disease whose soft wood permits easy excavation of nesting holes; the sap running down the trunk deters snakes and other predators (McFarlane 1992). Red-cockaded Woodpeckers nest in small groups or clans, requiring large areas of undisturbed forest. Each clan has "helpers," non-breeding birds that aid in feeding the nestlings (McFarlane 1992). These woodpeckers were the primary control of the southern Pine Beetle, a major pest in pine forests; after destruction of old-growth pine forests, which endangered these birds, Pine Beetles proliferated and destroyed other types of pines (McFarlane 1992).

Prior to the commercial logging of the early 20th century, these woodpeckers may have numbered in the hundreds of thousands. Nineteenth century records exist of Red-cockaded Woodpeckers as far north as northern New Jersey and southeastern Pennsylvania, and west to Missouri (Jackson 1994). Gradually, their range shrank as pine forests were destroyed; by 1946 the species was gone from Missouri, and by 1976 from Maryland (Jackson 1994). Populations in Tennessee declined to a single bird by 1992, and they disappeared from northern Mississippi in 1977; Kentucky and Virginia have only a few family groups (Jackson 1994). In the Southeast, clans became rare and widely separated from one another as millions of acres of old-growth pine were logged. When listed on the Endangered Species Act in 1968, programs to prevent its extinction were launched. Inbreeding of Red-cockaded Woodpeckers is apparently occurring in populations isolated by forest fragmentation (Jackson 1994). Some females have been physically translocated to isolated groups without females to counteract this problem (Jackson 1994). Nest holes have been artificially created, and existing nest holes have been modified with steel plates, restricting the size of the opening to prevent predators and larger birds from entering the nest hole (Jackson 1994).

The problem of declining habitat remains, however, and some conservation organizations, including the Biodiversity Legal Foundation, have successfully taken the Forest Service to court concerning their replanting policies, obtaining court orders mandating replanting with Longleaf Pine to benefit the Red-cockaded Woodpecker. At present, only about 30 known clans remain, with South Carolina and Florida having the largest numbers; the entire population of the Red-cockaded Woodpecker may not exceed 7,400 birds (Collar *et al.* 1994).

One haven for the Red-cockaded Woodpecker is Eglin Air Force base, located on the Florida panhandle. This 460,000-acre base preserves the world's largest remnant of Longleaf Pine forest, which occupies 320,000 acres of the base (Stevens 1996); 10,000 acres of this forest are the largest remaining old-growth Longleaf Pine in the world, with many 400-year-old trees (Biondo 1997). The Nature Conservancy has spent years conducting biological surveys and has discovered that more than 90 rare or imperiled species, including a salamander new to science, inhabit the base (Biondo 1997). Eglin protects 1,200 plant species, with numerous threatened species among these. Military activities are carried out as carefully as possible, and the base employs a full-time chief of natural resources with a staff of 25 (Biondo 1997).

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The military conducts munitions tests on Eglin Air Force Base, causing fires that have inadvertently benefited the ecosystem. The piney woods of the Southeast need fire, without which shade-tolerant hardwoods begin to intrude on Longleaf and other native pine stands (Jonas 1993). At present, Eglin officials conduct controlled burns to maintain this habitat (Stevens 1996) and are removing non-native and overabundant plants and trees (Biondo 1997). To return the Longleaf Pines to former abundance, more than 3 million seedlings have been planted, restoring 200,000 acres over the past five years (Biondo 1997).

The Gulf Coastal Plain Ecosystem Partnership, a plan to link populations of Longleaf Pine forests, was formed in 1996 to protect 840,000 acres of contiguous forest held by seven major landowners in northern Florida and southern Alabama (Biondo 1997). The partnership has signed a memorandum of understanding that encourages cooperation between the diverse owners, from private logging companies to state forest departments and water management districts (Biondo 1997). More than 160 rare or imperiled plants and animals reside in these lands, and Eglin Air Force Base's land has been the best preserved of any because of limited human intrusion and very little logging. It also protects a sizeable population of threatened Gopher Tortoises (*Gopherus polyphemus*). This keystone reptile excavates deep tunnels and cavities which provide habitat and shelter during fires for hundreds of animals, including threatened species.

Southern Bald Cypress (*Taxodium distichum*) swamp forests were once found in many low-lying areas of the

South, but today, the Okefenokee Swamp is the largest remaining tract. Plans to clearcut this huge forest were abandoned early in the century after logging proved unprofitable. Later, the Okefenokee was declared a National Wildlife Refuge, and it is one of the most important examples of this ecosystem, home to River Otters (*Lutra canadensis*), Alligators (*Alligator mississippiensis*) and abundant water birds.

Massive stands of ancient Live Oaks (*Quercus virginianus*) draped in Spanish moss evoke the very essence of the South. Although the majority of these huge trees have been logged, many survive that are 10 to 12 feet in diameter. They have a dense wood that was used in the construction of ships such as the USS Constitution. This ship was called "Old Ironsides" because this hardwood was impervious to cannonballs. The last sizeable stands of these picturesque trees are disappearing, however. Companies are buying wood lots with Live Oaks, cutting and replacing them with tree farms of fast-growing pine. As an added threat, a fungus first identified in the 1940s as "oak wilt," has been killing many Live Oaks. The disease chokes the flow of water into the tree and gradually kills it from the inside out, spreading through root connections which link Live Oaks growing in close proximity. In Texas, where this disease has killed many of these oaks, the Texas Forest Service has been successful in injecting chemicals that kill the fungus and digging trenches that break connections between these oaks.

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Predators of the Southeastern forests declined or disappeared after European settlement as a result of overhunting and persecution, leaving an imbalance in which White-tailed Deer proliferated without Grey Wolves or Mountain Lions to limit their numbers. Both the latter predators remain absent in the eastern United States, although there are unsubstantiated sightings of Mountain Lions in Maine and elsewhere. A few Grey Wolves have entered northern Maine in recent years, and some conservation organizations have proposed reintroductions of the species into Adirondack Park in New York state or in northern New England. Red Wolves (*Canis rufus*) were totally eliminated by predator control programs and hybridization with the Coyote, reaching extinction in the wild by 1973 when the last wild members of the species were taken into captivity. This uniquely American species, which until recently was considered to have been native to only the southeastern United States, is now thought to have been distributed throughout eastern North America, based on DNA testing showing close relationships between the Red Wolf and wolves of eastern Canada, which have managed to persist to the present. The species was larger in northern states and preyed on deer and elk. Red Wolves survive today as a result of the 14 animals that formed the nucleus of the Fish and Wildlife Service's breeding colony. By 1993, more than 233 animals resided in 31 breeding facilities. Several successful releases have taken place in North Carolina and other eastern states, and about 100 Red Wolves survive from these releases.

West of the Mississippi River, pine forests in the mountainous regions of the Southwest were also heavily logged. A resident of these forests, the southern Mexican Spotted Owl (*Strix occidentalis lucida*), a race of the Spotted Owl, whose northern race inhabits old-growth forests of the Pacific Northwest, has become very rare. This owl, like its northern relative, requires undisturbed forests. The dominant tree of the southwestern forests is the Ponderosa Pine (*Pinus ponderosa*), which towers 180 feet tall and can live 500 years (Jonas 1993). Originally, these trees covered hundreds of thousands of acres in northern Arizona, New Mexico, and neighboring states; old-growth pine forests also stretched south into northern Mexico. Beautifully adapted to the dry, mountainous habitat, Ponderosa Pines often grow in large, pure stands. These forests have very little old growth left today, and Mexican Spotted Owls have disappeared from national forests in Arizona and New Mexico after the oldest trees were logged (Johnson 1995).

Many unusual and endemic species live in pine and juniper forests of the Kaibab Plateau on the north rim of the Grand Canyon. The Kaibab Squirrel (*Sciurus aberti kaibabensis*) is confined to this plateau. This beautiful squirrel is considered by most authorities to be a subspecies of Abert's or Tassel-eared Squirrel, but some zoologists treat it as a separate species. One of the most dramatic looking of all squirrels, the Kaibab is dark brown, with long tassels on its

ears, and a snow-white bushy tail. Its close relative, Abert's Squirrel, is dark, grizzled gray on its back and tail. Feeding mainly on conifer seeds, these squirrels suffer high mortality from hunting, road kills and natural predation by hawks (Whitaker 1980). Their habitat is restricted, and they are considered a rare and endemic animal. Ecologically, these squirrels are important in helping the Ponderosa Pine reproduce. They dig for truffles and absorb their spores, which enter their feces. When their feces are deposited near Ponderosa Pines, they spread the spores to the tree's roots, which grow into a fungus, triggering the tree's reproductive biology. In the spring of 2000, wildfires raged through their habitat, undoubtedly causing the squirrels high mortality.

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The problem of illegal logging is growing in the national forests, and a recent threat is the invasion of forests by drug growers. These people have entered roadless federal lands in the West and are seldom detected because of the remoteness and size of many of these tracts. In Los Padres National Forest, they destroyed large sections of forest in 1995 and 1996 to plant marijuana. After cutting trees, they cleared brush with herbicides which killed native plants, many of which are rare and protected. They also diverted scarce water from streams to irrigate their plants, which eliminated native plants dependent on that water. The drug growers put out poison to kill animals, such as deer, they feared might eat the marijuana. This situation presents a major threat to many species of wildlife, and especially to California Condors, who have been reintroduced to Los Padres National Forest and feed on carrion.

Ancient old-growth pine forests covered much of northern Mexico until a few decades ago. Large-scale logging has been felling these great trees, and what reserves have been set aside to protect the remaining patches of old growth are not carefully patrolled to guard against illegal logging. The Imperial Woodpecker (*Campephilus imperialis*), the world's largest woodpecker and one of the most beautiful, declined to extinction as a result of failure by both the Mexican government and private conservation organizations to preserve its habitat. Its decline began from hunting, and logging removed its feeding and nesting habitat during the first half of the 20th century. Several of these birds were sighted in the 1990s, but because no emergency action took place to preserve these birds in their last retreat, they disappeared. Each pair of Imperial Woodpeckers required a habitat of at least 25 square kilometers, and no area of old-growth forest this large now remains in the Sierra Madre Occidental (Lammertink 1996). Only a few fragments of old growth survive in this huge area, and even these are in imminent danger of being logged.

Mexican logging companies offered local people $2,000 per household for permission to log, and this may have been the deciding factor that led to the end of Mexico's old-growth forests. All that remains of the Imperial Woodpecker are museum specimens. A photograph of three specimens was recently published in the article, "The Lost Empire of the Imperial Woodpecker," in *World Birdwatch* (Lammertink 1996). Martjan Lammertink concluded after his field survey that if the Imperial Woodpecker still exists, no breeding habitat remains and, at most, one or two solitary birds may be left who must fly over huge areas to find food (Lammertink 1996).

A courageous defender of the Sierra Madre forests, Mexican activist Edwin Bustillos has risked his life to fight the drug lords who have taken over large areas in these forests for cultivation of drug plants. In several incidents, Bustillos had five ribs and his arm broken and spent a month in the hospital from injuries sustained when attacked by drug dealers. In 1996, he received the Goldman Environmental Award for his long-term efforts on behalf of these endangered forests.

A beautiful parrot also inhabits these same pine forests. The Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*) once flew in large flocks in search of pine seeds, but its populations have declined from loss of old-growth forests and illegal shooting. The species is listed on the US Endangered Species Act, as endangered by the *2000 IUCN Red List Species*, and on CITES Appendix I, which bans all commercial trade. These large green parrots have red feathers on their foreheads, shoulders and thighs, and bare skin surrounding their yellow eyes. Their large hooked beaks aid them

in prying open pine cones. Native to Sierra Madre Occidental of eastern Mexico and, originally, pine forests in Arizona, Thick-billed Parrots live mainly above 2,000 meters. Heavy logging of old-growth pine forests has destroyed 99 percent of its habitat and removed the huge, old trees it needed for nesting (BI 2000, Collar *et al.* 1994). A field survey in 1994 in southern Chihuahua uncovered massive forest destruction and the penetration into its habitat of drug-growers, cattle and loggers (Collar *et al.* 1994). Populations have declined from flocks of thousands seen in the 1950s (Lammertink 1996) to about 5,000 in 1992 and only 1,000 to 4,000 in 1995 (BI 2000). Reintroductions into Arizona of captive-bred birds have not been successful because the birds did not know how to avoid predators or forage for pine seeds (BI 2000).

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Some highly threatened birds persist in unlogged portions of northern Mexico. The beautiful, iridescent Eared Quetzal (*Euptilotis neoxenus*), for example, was formerly common but is now confined to corridors of unlogged trees along rivers. These bits of forest are, at the present at least, inaccessible to loggers (Lammertink 1996). These quetzals require large trees for nesting and lay their eggs in cavities created when large tree snags fall off. Such trees, however, are rare and may disappear altogether in the future, since loggers cut them down as a general rule. It is considered Near-threatened, and close to qualifying as Vulnerable by BirdLife International (BI 2000). The Tufted Jay (*Cyanocorax dickeyi*) is another striking bird with a stiff, bristly, black fan crest on his head and forehead, unlike any other jay. This species is endemic to a limited area in the southern Sierra Madre Occidental, in mixed forested hillsides of oak, dense evergreen and deciduous forest near watercourses. Although a Near-threatened species (BI 2000), it has, nevertheless, no protected reserve.

Pine forests extend south to central Mexico, and up to 30 million Monarch Butterflies (*Danaus plexippus*) from the eastern United States and Canada migrate up to 2,000 miles to several groves of fir trees where they spend the winter clinging to branches in a semi-torpor. These butterflies constitute 90 percent of the species' population, and scientists believe that they have wintered here for more than 10,000 years (Aridjis and Brower 1996). Their migration is a biological mystery and unique among butterflies. Until the fir groves, where they festoon the tall trees like dazzling orange and black ornaments, were discovered, no one knew where they spent the winter. Even now, their method of locating this particular forest remains unknown. The butterflies that fly south are third generation ancestors of the ones who wintered in Mexico the previous year. On warm days, they wake from their torpor and venture out to take nectar, and in the spring, they head north, breeding along the way (Pyle 1981).

Entirely dependent on these groves of firs, which shelter them from the freezing rains that fall in this high-altitude forest, the Monarchs are threatened by logging. In spite of a 1986 order by Mexican President Miguel de la Madrid to protect the five wintering populations, all located in close proximity, the surrounding trees were not given protection. Local people cut trees for fuel and building materials, and cattle trample fir seedlings (Aridjis and Brower 1996). They have logged up to the very limits of the groves, and without the protection of bordering trees, the butterflies are more vulnerable to cold spells, dying in unprecedented numbers. Snowstorms and cold weather killed millions of these fragile butterflies in 1991 and 1995.

Ann Swengel and Dr. Paul Opler, who coordinate nationwide butterfly counts for the Xerces Society, a butterfly conservation organization, began noticing declines in Monarch populations in the United States, and scientists have seen many declines in areas where they were previously abundant.
Conservation of the precious fir trees upon which the species winters is a key to saving this species. Dr. Lincoln P. Brower, professor of zoology at the University of Florida and a leading authority on the species, and Homero Aridjis, President of the Group of 100, a Mexican environmental organization, made a public appeal for the protection of the Monarchs' winter habitat in an Op-ed article for *The New York Times* in January 1996 (Aridjis and Brower 1996). They maintained that all three countries--the United States, Canada and Mexico--should cooperate to purchase the

forests in keeping with the North American Free Trade Agreement (NAFTA) (Aridjis and Brower 1996). A comparison of forest cover in the Monarch groves based on aerial photographs taken in 2000 and in the 1950s, shows great losses in these protected trees from illegal logging over the past 40 years. The situation has reached crisis proportions, according to scientists. In response, the Mexican government has promised to protect the remaining groves and enlarge the reserve. Local people have expressed opposition, however, as they have traditionally logged the forests and have not profited from the tourists who come to see the butterflies. If this situation is not resolved in favor of the butterflies, these beautiful jewels that brighten fields and gardens may disappear from their breeding grounds in the United States.

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The ancient forests of the West Coast once stretched from northern California nearly unbroken through coastal Canada to southeastern Alaska, covering 70,000 square miles. Logging by Europeans began in the 19th century, and as the forests fell, a few voices were raised in protest. Even Horace Greeley, a promoter of "progress" and settlement of the West, exhorted Americans in 1851 to "spare, preserve and cherish some portion of your primitive forest" (Peck 1990). It was the fiery Scottish wilderness advocate John Muir who finally succeeded in convincing the US government to protect some of these ancient forests. He settled near California's Yosemite wilderness in the 1860s and began passionately denouncing the destroyers of nature, from loggers to livestock operators. Muir pointed to the political influences that allowed destruction to occur. During the 19th century, livestock swarmed in great numbers over wilderness areas. Muir described sheep as "hoofed locusts" and, in trying to get them removed from Yosemite, said, "As sheep advance, flowers, vegetation, grass, soil, plenty, and poetry vanish" (Peck 1990). When he saw the ancient Sequoias being cut, Muir was outraged:

> *Through all the wonderful, eventful centuries since Christ's time--and long before that--God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but He cannot save them from fools--only Uncle Sam can do that.*

Muir proved to be an adept politician, making friends with influential magazine editors and railroad magnates; President Theodore Roosevelt camped out with Muir in Yosemite in 1903 (Peck 1990). Through Muir™s influence, Yosemite became a national park in 1906, followed by Sequoia, Mt. Rainier, Crater Lake, Glacier and Mesa Verde National Parks (Peck 1990). In 1892, Muir established The Sierra Club conservation organization. If not for Muir's courageous and effective work on behalf of these forests, it is likely that very little old-growth forest land would remain today.

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These centuries-old trees, often covered in epiphytes, plants that get nutrients from moisture and air, and lichens, including one species that drapes over branches in delicate, lacy strands, exude a lushness reminiscent of tropical rainforests. More than 140 inches of rain per year produce luxuriant tree growth and a verdant understory of ferns and hardwoods. Bright green mosses and masses of ferns carpet the ground, and a great variety of mushrooms and lichens flourish in the damp environment. In the spring, the forest floor is carpeted with beautiful white trilliums and other flowers that contrast with the deep greens of the forest. Mist and fog enshroud the giant trees, which intercept the moisture from the atmosphere, supplying the trees and the entire environment with water throughout the year (Ellis and Kane 1991).* The southern portion of these forests is dominated by Coast Redwoods, with the record tree

reaching more than 365 feet in height. Its upper branches are more than 50 feet in length. They are among the most ancient as well, some over 2,000 years old (Middleton 1992). The great Redwoods of northern California gradually melt into a forest of mixed pines, fir, cedars and hemlock.

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*Along with the fine book by D. Middleton (1992), cited frequently here, *North America's Rain Forest. The Endangered Paradise*, by Gerry Ellis and Karen Kane (NorthWord Press, 1991), is an excellent resource, beautifully illustrated with the trees, plants and wildlife of these forests, and shows the devastating clearcuts contrasted with living forests. *Western Forests*, a book in the *National Audubon Society Nature Guides* series illustrates most wildlife and plant species, as well as discussing forest ecosystems.

Douglas Firs (*Pseudotsuga menziesii*) grow to ages of 700 to 1,000 years old in climax growth, veterans of hundreds of periodic fires; they may reach 325 feet in height (Jonas 1993). A tree 250 years old is considered young in an old-growth forest, while middle age is 400•500 years, and old age is more than 700 years (Middleton 1992). Recent research conducted in these forests indicates that rich diversity does not develop until forests are at least 200 years old (Moffet 1997).

Ancient Red Cedars (*Thuja plicata*) grew in abundance in these old-growth forests and were among the first to be cut by loggers. Old specimens are very rare at present, and activists recently saved one area with many exceptionally old and massive cedars from being logged. This forest, in Upper Priest Lake, northern Idaho, has cedars 1,500 years old. The largest trees are 20 stories tall, with trunks 10 feet in diameter. The ground beneath is carpeted with ferns, including the largest population of Braun's Holly Fern in the West. Old-growth cottonwoods also grow here. Endangered Woodland Caribou (*Rangifer tarandus caribou*), threatened Grizzly Bears, Fishers and Wolverines, rare Cutthroat Trout, endemic salamanders, and Harlequin Ducks are resident in the forest and wetlands. This forest covers 520 acres, worth at least $9 million to the lumber company that owns it. The US Forest Service was unable to obtain federal money to purchase it in 1996, and not until October 1997 was the grove preserved through a trade of land worth $8.7 million between the owner and the Forest Service.

More than 1,000 plant and animal species depend on old-growth forests (Egan 1994a). Invertebrate animals of the soil are highly diverse: an area 1 meter by 1 meter shelters 200,000 mites of 75 species (Middleton 1992). Fallen logs may take 500 years to rot, and this decaying wood is fed upon by the most diverse fungal network in the world (Middleton 1992). The hollow logs are used as nest holes by Red•backed Voles and other small species. The young of these voles feed on truffles that grow in the rich soil. At least 300 insect species have been described from the rotting•log community of organisms (Middleton 1992). A host of other insect species of the forest canopy have yet to be described.

Many vertebrates depend on the old-growth forests of the Pacific Northwest for their survival, and some of these live nowhere else. The Sitka Black•tailed Deer and Roosevelt Elk and a unique bluish strain of American Black Bear from southeastern Alaska are among these. Bats of several species--Long•eared, Hoary and Silver•haired--are major pollinators and insect-predators in forests of the Pacific Northwest. Roosting in the hollow trunks of ancient trees, these bats have declined in many areas because of logging. A great diversity of amphibians lives in the moist environments of these temperate rainforests. Among them are the Slender, Olympic, Pacific Giant and Del Norte Salamanders, Pacific Tree Frog and Tailed Frog.

The Northern Spotted Owl (*Strix occidentalis caurina*) may be the most famous resident of these forests. The struggle over old-growth forests became a bitter controversy focused on the fate of this bird, which was declared a Threatened species under the Endangered Species Act in June 1990. This owl is native to old-growth forests in northern California, Oregon and Washington, and each pair of owls requires up to 3,200 acres as territory, making it a naturally rare species (Middleton 1992). Northern Spotted Owls nest in natural tree cavities or holes created when great branches from living trees fall to the ground. The canopy above shields owlet chicks from the view of large birds of prey that fly above. These owls feed on the Red Voles, Dusky-footed Wood Rats and Northern Flying Squirrels that are abundant in old-growth forests. When these forests are cut and young second-growth forest takes over, Spotted Owls disappear (Seideman 1997). In spite of the protection of portions of their habitat, these owls have not recovered their numbers since listing on the US Endangered Species Act, and they continue to decline. The US Forest Service released extensive data compiled on the populations of these birds between 1985 and 1993, which showed a drop of 4.5 percent a year, with an accelerating rate of decline (Seideman 1997). Another threat to these owls is the recent invasion of their habitat by the larger and more adaptable Barred Owl, which is displacing the Spotted Owl in some areas. Even more ominously, interbreeding has taken place between the two species (Seideman 1997).

When the Northern Spotted Owl was listed as Threatened on the Endangered Species Act and large sections of its habitat protected, it became a focal point, polarizing pro-logging and anti-logging advocates. Owl haters urged others to kill these birds, who were blamed for ending the logging industry. Their cars sported bumper stickers such as "Kill an Owl, Save a Job." Such venom totally obscured the fact that the forests were being overcut and that logging jobs were destined to be eliminated anyway, as the last old-growth forests disappeared under the saw. A state in the heart of this owl's range, Oregon, found that reducing logging ended up helping its economy; an influx of technology businesses provided better salaries than those paid for logging jobs (Egan 1994b, Verhovek 2000). The Governor of the state supported the logging restrictions as helping to maintain the overall quality of life in the state, preventing floods and attracting tourists, which are supplying another large segment of the state's revenues.

Habitat Conservation Plans (HCPs), authorized under the Endangered Species Act may be contributing to the Spotted Owl's decline. Under these plans, agreements are negotiated with landowners which include a provision known as "no surprises." This gives landowners assurances that once the regulations on their properties have been agreed to, they are exempt from further restrictions. Should new populations of an endangered species be discovered on their property, they have no obligation to protect them. Habitats of Spotted Owls in old-growth forests in Washington State have been bartered away in HCPs that, in the view of Eric Hanson, biologist for the Yakima Indian Nation in Washington state, will end in reducing the state's populations of this species by 35 percent, from 880 breeding pairs to 550 (Seideman 1997). These HCPs allow habitat destruction and other actions that can result in deaths of Spotted Owls. The Forest Service collected population data on these owls for the years between 1994 and 1996 but failed to issue the results (Seideman 1997).

The Clinton Administration sponsored a series of local meetings to resolve differences. These resulted in plans to federally fund job•training for loggers who might become unemployed by logging cutbacks. Even so, logging interests sued the federal government to nullify the stricter quotas, and the California Forest Products Association unsuccessfully petitioned the Fish and Wildlife Service in October 1993 to remove the Northern Spotted Owl from the Endangered Species Act, claiming the species was mistakenly placed on the list. This case was argued all the way to the US Supreme Court which, in the summer of 1995, made a historic decision upholding the Endangered Species Act and its protection of endangered species' habitats.

The Timber Salvage Act of 1995 made a mockery of previous attempts to mediate between loggers and conservationists, allowing a year and a half of totally unregulated logging in the habitat of the Northern Spotted Owl and other threatened species. This law had the stated purpose of taking only fallen and dead trees, but in practice, tens of thousands of old-growth, healthy trees were logged. In its quarterly report on the Timber Salvage Act, issued February 29, 1996, the Forest Service reported that an astounding 2.1 *billion* board feet had been cut since passage of the law. The Forest Service's stated objective was to sell 4.5 billion board feet by the end of 1996. By August 1996, some 2.9 billion board feet, the equivalent of 580,000 logging trucks full, had been cut under the Timber Salvage Act (Bass 1996). National forest lands to be logged totaled at least 50 million acres. Major habitat areas for many endangered and threatened species were among these lands. Fortunately, this law expired at the end of 1996.

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The Marbled Murrelet (*Brachyramphus marmoratus*) is also dependent on old-growth forests and has been seriously impacted by the logging that, since the 19th century, has destroyed 95 percent of its old-growth habitat in the US Pacific Northwest. This small, black-and-white seabird is a Threatened species on the US Endangered Species Act and is listed as Vulnerable by BirdLife International. Unlike any other seabird, this Murrelet nests high in the branches of 200- and 300•foot trees. Sometimes seen in offshore waters of the Pacific Northwest and Alaska, their nests are rarely found. In fact, only about 30 nests have ever been located in the Pacific Northwest--all high in the crowns of old-growth forest trees.

A researcher who was studying the ecology of old-growth tree canopies made an exciting discovery of a Marbled Murrelet nest. He photographed the adult on its nest, made of lichens, with a small fish in its mouth for its chick for *National Geographic* magazine (Moffett 1997). Despite surveys up and down the Pacific coast, this was one of the few nests found in 1996, and plans for logging near the nest site were stopped (Moffett 1997). A prime area for Marbled Murrelets is the Olympic National Forest in Washington state where large tracts were sold for clearcutting in 1996 under the Timber Salvage Act. In Umpqua National Forest, Oregon, over the weekend of March 23-24, 1996, several thousand-year-old Douglas Firs were cut; their age was determined by coring and ring counts. The Umpqua River has endangered populations of Coho Salmon (*Oncorhynchus kisutch*) and sea-run Cutthroat Trout, and logging may eliminate them. The Marbled Murrelet's nesting trees are being logged throughout the species' range. A few areas have been protected in Alaska, but they are declining rapidly, at a rate of 31 to 48 percent per decade, with little hope that sizeable areas of old-growth forest will be protected (BI 2000).

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The Pacific Yew (*Taxus brevifolia*)**,** found only in these forests of the Pacific Northwest, is considered a "trash species" by foresters who clear it away to make room for more valuable species. This plant grows in the undergrowth of old-growth forests from California to southeastern Alaska (Jonas 1993). It has recently been shown to contain a chemical substance, Taxol, that has proven effective in treating ovarian and other cancers (Middleton 1992). A rush to cut these trees and strip their bark to obtain Taxol threatened them with extinction until the chemical was successfully produced synthetically. Taxol will be a major new tool in treating cancers and will result in sales totaling many millions of dollars for the pharmaceutical industry.

These discoveries have taken place as the fate of the last stands of old-growth forests is hanging in the balance. Ninety-five percent of these forests in the United States, and more than 60 percent in Canada, have already been cut. Opposition to clearcutting is increasing, however. Lewis H. Nash is a member of an organization known as the "Environmental Air Force," which chronicles illegal cutting of Coastal Redwoods. Members pilot small planes over clearcuts and document the damage with photographs. Nash's work enabled an environmental lawyer to obtain an injunction in 1995 stopping logging the same day (Goldberg 1996a). In 1996, flying over the devastated forests of northern California, Nash remarked: "When I first started flying here 10 or 15 years ago, this was all the same, all primeval forest. All this has been pretty well hacked over" (Goldberg 1996a).

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One of the most heated debates over these forests involves the last privately-owned large tracts of redwoods. Commercial exploitation began in 1900 when Frederick Weyerhauser purchased 900,000 acres for $6.00 per acre, a ludicrously low price even in those days (Dietrich 1992). Almost all privately owned old-growth forests became depleted by the 1960s. One exception was a large tract of old-growth Coastal Redwoods and Douglas Firs in California's Humboldt County, in the northern part of the state, owned by the Pacific Lumber Company. This family-operated company had left most of its 200,000 acres intact and had been particularly protective of the most ancient trees in the 55,000-acre Headwaters Forest. In 1986, however, Houston financier Charles Hurwitz took over Pacific Lumber, using junk bonds. Hurwitz's United Savings Association of Texas failed, costing US taxpayers $1.6 billion, part of the savings-and-loan collapse (Brown and Stark 1995).

To pay his debts, Hurwitz began clearcutting the old-growth Coast Redwood and Douglas Firs. By 1995, he had cut 40,000 acres of the Headwaters Forest and nearby old-growth trees, leaving only 5,500 acres of virgin Coastal Redwood and 5,000 acres of virgin Douglas Fir (Brown and Stark 1995). This is one of the most extreme cases of abuse of private land in the history of this country. Two-thousand-year-old trees were turned into picnic tables, lawn furniture and patio decks. Logging was delayed by several lawsuits, and to protect nesting sites of Marbled Murrelets, the California Forestry Department recommended in 1995 that Hurwitz be refused permission to build a logging road into the 4,400-acre grove of the most ancient trees (Brown and Stark 1995). Two California Congressmen, George Brown and Pete Stark, proposed that the federal government engage in a debt-for-nature swap, in which the Federal Deposit Insurance Corporation, which has sued Hurwitz for his role in the failure of his bank, would, through a special arrangement set up by the President, exchange the redwoods for his debt (Brown and Stark 1995). Hurwitz rejected the idea, calling it a "so-called fantasy of debt for nature" and threatened lawsuits against the government for excessively limiting the use of his land (Goldberg 1996b).

The value of the Headwaters Grove is estimated at between $100 and $500 million, with many giant trees several thousand years old and 12 feet in diameter; individual trees are worth more than $100,000 each (Goldberg 1996b). The ecological and esthetic values, however, are inestimable. Hurwitz called environmentalists who blocked sale of these trees "extremists" and insisted that he expected to be paid "fair market value for these trees" (Goldberg 1996b). Acrimonious negotiations for the grove continued in 1996 and 1997, with environmentalists demonstrating against an agreement negotiated that would protect only 7,500 acres, instead of the 100,000 they wanted saved. Early in 1997, Hurwitz demanded that he be paid in cash rather than land that was offered by the state of California, land which many environmentalists thought should be protected (Golden 1997). The deal arranged with Hurwitz allowed extensive cutting of the remaining 100,000 acres of old-growth forest without regard for endangered species' habitat.

Members of Earth First! began protests, entering the land and attempting to block logging trucks, and a young conservationist, Julia Hill, who became known as Julia "Butterfly" Hill, climbed up near the top of an ancient redwood tree she called Luna and refused to come down. She stayed up in this tree for two entire years, until the

spring of 2000, while trees were cut in the surrounding area, until a sum of $50,000 was paid to the Hurwitz lumber company for Luna and 2.9 acres of surrounding forest, which were donated to Humboldt State University. She came down from the tree at last, a symbol of the extreme devotion and zeal that have been expended in attempts to preserve these ancient trees. The forest will continue to be cut, however, which will be a permanent loss to the environment and a stain on state and federal governments for not taking a stronger role to preserve the entire forest.

In a sad footnote, in November 2000, a vandal sawed a cut 32 inches deep and stretching 19 feet, or half the circumference, across the base of Julia Hill's tree, Luna. It appeared to have been done by a professional logger, judging from the precision of the cut. A team of specialists--an arborist, an engineer and a forester--was convened to try to save the tree (Quinn 2000). Metal braces were drilled into the tree spanning the cut. All efforts are being made to save this ancient tree from falling in winter storms. Visitors are being asked to stay away because the soil and hillside are being deeply eroded. It is a symbol of the senseless destruction of ancient forests.

Only 4 percent of the once vast and magnificent Coastal Redwood forests remain. These trees covered at least 2 million acres prior to logging, but only about 84,000 acres of virgin redwoods have been protected in state parks and the Redwood National Park; another 66,000 acres of logged and second-growth redwoods have been set aside (DiSilvestro 1990).

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Another major conservation struggle involves the magnificent Tongass National Forest in southeastern Alaska. This forest, covering 17 million acres, is the country's largest national forest--a mosaic of glaciers, mountains, fjords and islands covered by ancient trees. It makes up half of one of the largest remaining temperate rainforests on Earth, which extends 1,000 miles in an arc along the southeastern coast. At least 6 million acres of Tongass are--or were--old-growth rainforest (DiSilvestro 1990). Sitka Spruce, Western Hemlock, and Red and Yellow Cedar many hundreds of years old dominate the forest.

The Tongass is home to a number of rare animals. Approximately 10,000 Bald Eagles nest in the tops of trees (DiSilvestro 1990). More Grizzly Bears live in the Tongass than in the entire lower 48 states, denning in the holes of towering old trees. A race of the Grey Wolf known as the Alexander Archipelago Wolf (*Canis lupus ligoni*) inhabits the Tongass; numbering only about 1,000 animals, its population is in decline (Williams 1995). Logging threatens these wolves and rare wildlife, including the Queen Charlotte Goshawk (*Accipiter gentilis laingi*) and the Marbled Murrelet (FWS 1994). The Wolf and the Goshawk are candidates for listing on the Endangered Species Act. These and other species of this beautiful area cannot survive in clearcuts and logged-over forests. The American Rivers organization has listed Tongass's Thorne River as one of the 10 most endangered in the United States, having become silted and its banks eroded from logging (Williams 1995).

The cutting of the Tongass's giant trees began in 1833, and by 1926, six sawmills were operating; by 1930, most of the lowland and easily accessible timber and giant old trees had been cut (DiSilvestro 1990). In the 1950s the Forest Service allowed cutting of ancient trees in rugged, steep areas and opened the way for a wood pulp industry to be fed by clearcutting. The Service offered two 50-year contracts at bargain-basement prices, instead of the usual three- to five-year contracts (DiSilvestro 1990). It signed an exclusive contract with the Ketchikan Pulp Corporation and, unlike other national forests where contracts are open to bidding, this contract was awarded during secret meetings from which the public and conservation organizations were excluded. From this time onward, 200 million board feet or more of old-growth forest were logged annually from the Tongass National Forest (DiSilvestro 1990).

The Alaska National Interest Lands Conservation Act of 1980 divided most of the state among federal, state and native interests. Within the law was a provision requiring maximum logging levels in the Tongass National Forest,

with the quota of 4.5 *billion* board feet to be logged every decade, with annual subsidies of $40 million from the federal government for logging roads and other aid to timber companies (DiSilvestro 1990). In the 15 years that followed, billions of board feet were logged in this magnificent rainforest, at a financial loss to the taxpayer.

National organizations, including the Taxpayers for Common Sense based in Washington, DC, criticized the clearcutting of this and other national forests which provide no income to the federal treasury and are entirely subsidized by public funds (Schmitz 1996). A 1995 General Accounting Office report found that Tongass's Timber Program was the biggest money loser in the National Forest system, with a negative net return of $102 million to the US Treasury between 1990 and 1994 (Schmitz 1996). More recently, a study by the John Muir Project found that in the years 1997 through 1999, the National Forest Service Timber Sale Program operated at a net loss to taxpayers of more than $3.3 billion (Hanson 2000). This research found that less than 3 percent of the country's total annual wood consumption, and less than 4 percent of the sawtimber used for construction, comes from national forests (Hanson 2000). A nationwide poll in 1998 found that 69 percent of Americans oppose allowing timber companies to log the national forests (Hanson 2000).

The fight to save these forests is being waged in the courts, with public criticism and legal actions brought by conservation organizations. A 1987 book, *The Tongass. Alaska's Vanishing Rainforest*, dramatically illustrated the great beauty of this forest and the ravaging effects of logging, including clearcuts on steep, erodable slopes. This publication served as a catalyst for the passage of the Tongass Timber Reform Act of 1990 that stopped the $40 million subsidy to loggers and set aside 1 million acres to be closed to logging (Ketchum and Ketchum 1994). It did not stop or appreciably slow logging elsewhere in Tongass, however, and called for 150 million board feet a year to be cut. The book was updated in 1994 and described the continuing bitter battle being waged to protect this vast area (Ketchum and Ketchum 1994). In 1997, the heavily polluting Ketchikan pulp mill was finally closed. The Forest Service's 10-year plan for Tongass National Forest, finalized in May 1997, opened up 670,000 acres to logging, authorizing the cutting of 220 million to 267 million board feet of timber annually (this is enough to load 50,000 logging trucks or build more than 20,000 houses a year) (Cushman 1997). The Forest Service stated that the portion of land that would be set aside would make it unnecessary to list the Alexander Archipelago Wolf and the Queen Charlotte Goshawk on the Endangered Species Act. Conservation organizations criticized the plan and the failure to support listing of these species. The Alaskan Congressional delegation expressed its disappointment that more timber had not been open to logging (Cushman 1997). The 100- to 125-year cycle of cutting by the Forest Service assured that old-growth forests and their complex and diverse ecosystems will disappear.

The Forest Service held nationwide hearings during the summer of 2000 regarding a proposal that some 50 million acres of national forests be protected from road-building. This proposal specifically exempted the Tongass National Forest. The Forest Service plan would allow massive road construction and logging in the Tongass's remaining pristine forests. In a surprise decision prior to leaving office, President Bill Clinton authorized the inclusion of 9.3 million acres of the Tongass National Forest in the final plan; although delayed until 2004, this was an extremely important event, condemned by the Alaskan Congressional delegation (Hughes 2000). The plan calls for $13 to $20 million to be spent in Alaska creating jobs lost in the timber industry. The plan had drawn more than 1.5 million letters and e-mail messages, the overwhelming majority in favor of banning road-building. In spite of opposition to the designation of wilderness in this vast national forest, conservationists succeeded in obtaining a moratorium on logging of 9 million acres, pending the results of studies on whether they qualify for permanent protection under the Wilderness Act (Earthjustice Legal Defense Fund 2001).

Another huge national forest in Alaska, the Chugach, located at the headwaters of the salmon-rich Kenai River, has received far less attention than the Tongass, in spite of being the second largest of all US National Forests. In 1996, the Forest Service cut nearly 16 million board feet in this old-growth forest.

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The future of forests in the United States is at a dramatic turning point. During the summer of 2000, devastating wildfires broke out in the Western United States, primarily in national forests. More than 6.7 million acres burned, along with hundreds of private homes (Janofsky 2000). Within months, the Clinton Administration proposed a major new approach to the national forests, dictating extensive thinning of millions of trees and the removal of brush to prevent future wildfires (Jehl 2000). This plan was based on the theory that the fires were caused by too little logging, resulting in dense forests with underbrush that caught fire and spread uncontrollably. Pro-logging Members of Congress, western Governors and logging companies immediately endorsed the plan (Janofsky 2000, Jehl 2000). Some Governors wanted even more money for the program (Janofsky 2000). The proposed thinning would cost taxpayers $12 billion over 15 years (Jehl 2000). This was challenged by a report issued by the Congressional Research Service soon after the fires were extinguished, which concluded that there was no connection between the level of logging and wildfires (Egan 2000). Other critics included the Forest Guardians of New Mexico, who contended that the fires were the result of decades of industrial logging in which the largest trees were taken; it suggested that instead of thinning, logging subsidies be directed at badly needed projects to control soil erosion, protect water quality and enhance wildlife habitat (Hitt 2000). Environmental groups opposed the logging portion of the proposal as a tool for fire prevention (Janofsky 2000).

As the ideal example of how national forests should be managed, the Clinton Administration proposal pointed to an Arizona Ponderosa forest that had been thinned and did not burn. Ponderosa forests are not typical, however, of all forests, tending to be open with little understory. Other types of forests, such as old-growth temperate rainforests, are not open, and drastic thinning of their undergrowth would result in more, not fewer fires. Moreover, nutrients would be lost, erosion encouraged and wildlife habitat destroyed by such thinning. Dr. Paul R. Epstein (2000), a scientist with Harvard's Medical School Center for Health and Global Environment, concluded that the wildfires were precipitated by global warming, which caused the drought that dried out these forests, making them vulnerable to wildfires. Epstein proposed that the most important reaction to these fires would be to control global warming and restabilize the climate system.

An extremely important policy statement was made by Forest Service chief Mike Dombeck in January 2001, when he ordered the protection of the largest and oldest trees on Forest Service land (Jehl 2001a). In explaining his decision, Dombeck said, "In the future, we will celebrate the fact that national forests serve as a reservoir for our last remaining old-growth forests and their associated ecological and social values" (Jehl 2001a). Only about 3 percent of national forests is old-growth forest, yet these forests are among the most important refuges for rare and endangered species. Dombeck's statement and the philosophy behind it are reminiscent of John Muir or Henry David Thoreau, an extraordinary reversal from the utilitarian view of forests as tree farms that has held sway since the beginning of the Forest Service. In fact, it had been Forest Service policy that the oldest and biggest trees be cut first (Jehl 2001b). The new Republican Administration and the Senate panel overseeing the Forest Service announced that hearings would be held on the new policy, which runs counter to the one backed by President George W. Bush (Jehl 2001b). Dombeck was asked to leave his job soon after President Bush took office. Logging in national forests has declined from 1989, when 12 billion board feet were cut, to about 3 billion board feet in 2000 (Jehl 2001b). Loggers are expected to lobby hard to cut these last old-growth trees because of the huge amount of dense wood they contain.

Although Canada's forests are far more extensive, with greater amounts of old-growth, they are being logged at an extremely rapid pace. The 1980s and early 1990s witnessed the clearcutting of millions of acres of Canadian forests, from boreal coniferous woodlands to deciduous and mixed forests in the east to the ancient temperate rainforests of British Columbia's coast. The logging that has removed vast tracts of Canada's forests is a major factor in the decline of the continent's colorful and ecologically important wood warblers and other songbirds. British Columbia's mountainous terrain is not conducive to clearcutting because of erosion, but this has been the method used to raze hundreds of thousands of acres. Wilderness valleys with forested slopes have been denuded and the soil and debris washed into salmon streams and rivers, clogging and destroying them. The Bowron Valley in central British Columbia was turned into a moonscape in 1992 when 1,600 square kilometers were clearcut; efforts to replant this huge area have not been successful (Devall 1993). Habitat of the Grizzly Bear in British Columbia's high-altitude forests has been devastated along with its forest wilderness home elsewhere in Canada (Devall 1993).

Research on Sitka Spruce (*Picea sutchensis*) canopies on Vancouver Island, along the British Columbia coast, has produced 300 new species of insects, and scientists state that this environment will reveal hundreds more. According to one biologist, "We have a virtually unexplored biological frontier in our own backyard" (Moffett 1997). A highly unusual Sitka Spruce, called "Golden Spruce" (*P.s. aurea*), grows on Graham Island in the Queen Charlotte Islands to the north of Vancouver Island (DePalma 1997). This extremely rare color phase had only one known adult specimen in the wild, the result of a genetic quirk that causes chlorophyll to break down, giving the needles a golden yellow hue when exposed to sunlight (Comeau 1997). Standing 160 feet tall, and 300 years old, the Golden Spruce was known to the native Haida tribe, who revered it, as "kiidk'yaas," or ancient tree (DePalma 1997). (A color photograph of this dazzling tree was published in the *Canadian Geographic* magazine in May/June 1997.) The Haida believed that the tree would be admired until their last generation and that it held the spirit of a young Haida boy who survived, along with his grandfather, the demise of their village, which was destroyed by an angry Creator (Comeau 1997). As they walked away, the elder warned the boy not to look back, but the boy disobeyed and was turned into a tree that came to be venerated as the embodiment of the tribe's spirit (Comeau 1997).

In January 1997, a mentally unbalanced man swam across the sound to the island and cut the tree down. This caused shock and dismay among the Haida, who felt they had failed in protecting this most important part of their traditions and believed that its death predicted their own demise (Comeau 1997). Fortunately, a few cuttings had been taken from this tree in 1986 by a horticulturist, who brought them to the Botanical Garden at the University of British Columbia and propagated them. Two 5-feet-tall, scrawny trees were produced, and they are all that remain of the magnificent Golden Spruce (DePalma 1997). The Haida took about 100 cuttings from the top of the felled tree and asked the scientific community to help save it. They accepted one of the two propagated specimens from the university (Comeau 1997).

Vancouver Island, just north of Washington state, is one of the most magnificent scenic areas in the world. The struggle to stop clearcutting of its ancient forests has become pitched. One highly endangered species resident on this island is the endemic Vancouver Island Marmot (*Marmota vancouverensis*), one of 11 species of marmots in the world, all native to the Northern Hemisphere (Nowak 1999). Much of the Vancouver Island Marmot's habitat has been destroyed by development for ski slopes and logging, which apparently removed important migration corridors between colonies. This exposed the marmots to predation and prevented the establishment of new colonies (Thornback and Jenkins 1982). Colony sites became isolated, and vacant areas were not reoccupied, causing inbreeding (Thornback and Jenkins 1982). The Federation of British Columbian Naturalists formed a Vancouver Island Marmot Preservation Committee to conduct surveys and publicize the need to protect the Vancouver Island Marmot (Thornback and Jenkins 1982), yet in spite of long-term studies, logging continued. Surveys in 1979 and 1980 found only 11 colonies with 50 to 100 individuals (Thornback and Jenkins 1982). A 1984 survey found 231 animals, and some captive breeding has been successful (Nowak 1999).

The *2000 IUCN Red List Species* lists the Vancouver Island Marmot as Endangered (Hilton-Taylor 2000). It is also listed as Endangered by the US Endangered Species Act, and as Critically Endangered by the British Columbia

Conservation Data Center of the province's Ministry of Environment. The Vancouver Island Marmot has been ranked in the most endangered category by the Center, as having few remaining individuals, and since this remnant population is continuing to decline, its extinction has become likely. By 1995, 11 colonies had declined to only eight, and the 1984 population of 231 animals had declined to only 150 animals. Biologist Andrew Bryant, chief scientist of the Marmot Recovery Foundation, conducted his Master's Thesis on the species and has continued to monitor it, according to the British Columbia Conservation Data Center. The population declined to a critical level in the late 1990s, and there are plans to take more animals into captivity to attempt captive breeding for future releases into protected habitat. In 1999, researchers found only 62 marmots left in the wild (NGS 2000). They took 27 into captivity for breeding programs. Bryant stated that the major threat to these animals was clearcutting, which greatly reduced their food supply; they are also vulnerable to predators (NGS 2000). The long-term plan is to reestablish these marmots in three separate sites and build populations up to 400-600 animals (NGS 200).

Vancouver Island's panoramic beauty is displayed in the 1994 film, fiRainforest of the Pacific Northwestfl (see Video, North America section). Aerial views of undisturbed forest and the majestic Clayoquot Sound contrast with large stretches of clearcut forest. Trees up to 270 feet tall and more than 1,000 years old grow on Vancouver Island, but less than one-third of the old-growth forest remains; at the making of the film only 4.5 percent of the forest was protected. The British Columbian government appointed a panel to recommend revisions to the logging plan for Clayoquot Sound and, to the delight of conservationists, issued recommendations in 1995 banning clearcutting and proposing strong streamside protections and so many safeguards that very little logging will be allowed (SCLDF 1995). In 1995, the British Columbian government announced that it would adopt all the recommendations made by the blue ribbon Science Panel. All commercial logging in pristine areas has been deferred until biological inventories are completed, according to the Rainforest Action Network (RAN). This does not mean a permanent end to logging in this beautiful Sound, and conservationists will need to continue the fight. The native-run Clayoquot Sound First Nations leaders are apprehensive that they may be pressured into joint logging ventures with timber companies, and they issued an unequivocal declaration calling for an end to commercial logging in all old-growth forests (Rosmarin 1995).

Forty miles north of Vancouver, old-growth coastal forests are being destroyed by commercial loggers to make way for urban and suburban growth. The Squamish River cuts through these forests and provides one of the great wildlife spectacles in North America. When salmon disappeared from almost every river of the Northwest and pollution killed off fish in many northern states, Bald Eagles migrated north to the Squamish River (Nickerson 1995). Almost 4,000 Bald Eagles from as far away as Wisconsin and the Rocky Mountains winter along the river, feeding on spawning salmon (Nickerson 1995). "Americans are strange," a Squamish Native American remarked, "They revere the eagle as the pride of their country, then ruin his home and make him so hungry he flees to Canada" (Nickerson 1995). Yet this sanctuary is now threatened. A 600-acre industrial park at the heart of the winter roosting grounds is planned by local officials, and logging has removed much of the forest already (Nickerson 1995). The Nature Conservancy began acquiring parcels of land for the establishment of Canada's first sanctuary for Bald Eagles (Nickerson 1995). The goal of conservationists is a preserve of 2,700 acres to protect this important feeding area (Nickerson 1995).

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The white bears of Canada live along 1,000 square miles of rainforest on the British Columbian coast and off islands. Their main breeding island, Princess Royal Island, harbors the largest number of these bears, which are a rare color phase of the Black Bear. The percentage is even lower on other islands (Russell 1994). The world population of these bears is estimated at only about 400 (NRDC 2001). A delightful book, *Spirit Bear. Encounters with the White Bear of the Western Rainforest*, by naturalist Charles Russell, recounted his visits to the island with two filmmakers, Jeff and Sue Turner, who were working on "Island of the Ghost Bear." Russell, who has been studying and helping

bears of many species throughout his life, wanted to write a book about the spirit bear to obtain sanctuary status for this island and its bears. The white bears on the island have been protected for thousands of years, first by the Native Americans, and now by the British Columbian government. They are so tame that Russell was amazed, having never encountered such friendly bears of any species. A young white bear came to inspect Russell and the filmmakers soon after they arrived, peering into their camera lens, leaving nose prints on the lens (Russell 1994). This bear would sit down near them, sometimes seeking their protection when larger Black Bears tried to take away salmon he had caught (Russell 1994). On one occasion, Russell followed the bear back into the forest to see where he went. After a long walk through the rainforest, the bear found a soft area covered in bright green moss and decided to take a nap. He was so trusting that he went to sleep with Russell watching him only a few feet away. While asleep, the bear seemed to be dreaming, his eyes moving, legs twitching, and sometimes grunting (Russell 1994). Russell's book is illustrated with many photos of the bear fishing, sprawled on his back in the forest, and climbing about the rocks. This bear let himself be scratched with a stick and even tried to wrestle with Russell and Jeff Turner. Russell and the Turners left the island but returned after a year, and the bear came to greet them, sitting down a few feet away as if they had not been gone at all (Russell 1994).

The entire range of this bear is slated for logging. The Black Bears living on these islands, which carry white bear genes and are only a bit less tame than the white bears, are hunted under British Columbian law, which allows two bears per hunter each season. When they were filming the bears, some Swiss, German and Austrian hunters had arranged a bear hunt (Russell 2000).

The film, fiGhost Bear,fl shown on PBS's Nature series in 1994, captured an island little changed for 10,000 years, never logged and teeming with wildlife. Black wolves, mergansers, Beavers, salmon and Bald Eagles live in this mossy, verdant forest with towering trees. The filmmakers urged protection for the bears and the forest. Other defenders of this bear and its forest are the members of the Kitasoo and Gitga™at Indian tribes of British Columbia, who believe that the white bears were created by a raven who came from heaven and decreed, "The white bears will live here forever in peace." The tribe wants to create a park of the entire area to protect the bears and the rainforest. Logging proceeded, however, within the proposed park, and a logging company cut a road through one island's ancient rainforest and the ancestral Kitasoo deer-hunting grounds. The Rainforest Action Network (RAN) began in the mid-1990s to help create a sanctuary, which is opposed by the British Columbian government. Twenty million acres of rainforest in the province may be cut, and RAN is campaigning to convince US customers to cancel contracts and refuse to buy products from these ancient forests (Rosmarin 1995).

A Canadian couple, Ian and Karen McAllister, have formed an organization, Rainforest Conservation Society, to preserve the habitat of the Ghost Bears and the Great Bear Rainforest. Their book, *The Great Bear Rainforest, Canada's Forgotten Coast*, published in 1997 by Sierra Club Press, eloquently describes this magnificent region and their work to help preserve it. The Natural Resources Defense Council (NRDC), headquartered in New York, took on the cause in 2000, urging a consumer and commercial boycott of International Forest Products (Interfor), a logging company that is cutting the old-growth forests in the heart of 18 untouched rainforest valleys in the Great Bear Rainforest. As the company was about to clearcut East Creek on one island, it was stopped by construction of a tribal longhouse by the Gita™at Tribe at the mouth of the creek, aided by NRDC, which forced the company to suspend its plans (NRDC 2001). Negotiations between conservation groups and six logging companies, including Interfor, had appeared to achieve protection of the Great Bear Rainforest, but Interfor pulled out of the agreement and recently began logging within the habitat of the white bears. This devastation of a magnificent environment does not even make economic sense, as there could be a sizeable market for videocam views linked to a satellite of these enchanting bears and their mossy, green forests, paid for by viewers around the world for a long-term profit far exceeding that which will accrue to the loggers. The Giant Panda is also a charismatic species, and conservation donations from zoos now total $10 million a year or more to preserve the species™ habitat. The white and black bears of this wilderness deserve no less.

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Further inland, the Wood Buffalo National Park, bordering Alberta and the Northwest Territories, is the sole breeding ground of the endangered Whooping Crane (*Grus canadensis*). This enormous park, designated a United Nations World Heritage site, was logged in large clearcuts from the end of World War II until 1992, a tragic loss of old-growth boreal forest (Devall 1993). The logging was stopped by a lawsuit brought by the Sierra Club Legal Defense Fund (now Earthjustice Legal Defense Fund) in conjunction with the Canadian Parks and The Wilderness Society. The suit was based on the Canadian National Parks Act, which states, "The National Parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations" (Devall 1993). The Peace River, flowing through Wood Buffalo, is so contaminated by dioxin from the Daihowa pulp mill upstream that natives no longer eat the fish, their major food staple, from the river (Devall 1993).

By the end of 1988, one-third of the land surface of Alberta, Canada-- 221,000 square kilometers--had been logged. Much of Saskatchewan's former forested land--more than one million hectares--has been clearcut and not replanted, nor has it regenerated naturally (Devall 1993). Manitoba, south of Hudson Bay, protects less than 2 percent of its territory from development and logging. In 1989, the Manitoba government opened up an area the size of Ohio, 108,000 square kilometers, to logging (Devall 1993). Logging in Manitoba, Saskatchewan and Alberta fueled $10 billion in new pulp mills, major water and air pollution sources (Devall 1993).

Eurasian Temperate Forests

Eurasian Temperate Forests: The Siberian Tiger's Domain

Russia's coniferous forests form the major part of the Eurasian taiga, a mixture of spruce, birch and other evergreens, covering 3 million square miles, two•thirds of the country's land surface (Sparks 1992). It is the world's largest forest of any type, more than twice the size of the Amazon rainforest (Stewart 1992). Russia's taiga makes up half of the world's total area of coniferous forest and about one-quarter of the entire forested area of the world; the Siberian portion alone is one•third larger than the whole of the United States (Sparks 1992). The forested land east of the Ural Mountains covers 5 million square miles (Linden 1995). Further south, deciduous trees mix with aspen, birch and alder (Sparks 1992). This entire, vast forest may once have been the domain of the Siberian Tiger (*Panthera tigris altaica*), as its fossilized bones have been found on Lyakhov Island off the north coast of Siberia (Matthiessen 2000).

The vast expanses of taiga forests were opened up to international logging after the dissolution of the USSRF. By the early 1990s, about 304 million acres, two•and•one•half times the size of France, had been clearcut (Stewart 1992). Each year an additional 12 million acres are logged (Lean and Hinrichsen 1992). Commercial exports of Siberia's logs to the United States have been encouraged by various corporations and the US Department of

Commerce. Logging has also been intense in Russia's Far East, an area of great biological diversity, with many resident endangered species.

A nearly pristine and stunningly beautiful part of Russia is the Kamchatka Peninsula in the Far East, jutting into the Pacific Ocean. This area has 29 active volcanoes, wild rivers, hot springs, and beautiful forests. An endemic tree, the Kamchatka Fir (*Abies gracilis*), grows only on this peninsula. A relict of pre-Ice Age coniferous forests, it is a silvery fir with soft needles, which grows to about 70 feet in height; this once widespread tree is now restricted in range (Sparks 1992). The forests of Kamchatka are being heavily logged (Meulenaer and Vaisman 1996). Another threat is gold mining, as $10 billion worth of gold is thought to lie under the forests and lakes of the Peninsula (Specter 1997).

The Kamchatka Sable (*Martes zibellina*) is larger than sables in other parts of Russia and was nearly trapped to extinction in the 19th century (Stewart 1992). The Sable's habitat is dominated by Stone Birch (*Betula ermani*) forests with thick, grassy undergrowth covering the mountain slopes; some of these trees grow to be 600 years old (Stewart 1992). Mountain Ash provide berries which, along with an occasional fish, supplement the Sable's diet of voles (Stewart 1992). Unfortunately, anti-trapping restrictions are not being enforced in Russia's Far East, even in nature reserves. The Kronotsky Nature Reserve, covering 3,860 square miles on the peninsula's east coast, shelters 700 species of tundra, taiga and mountain plants, with a number of unusual endemic plants, including the beautiful Kamchatka Rhododendron (*Rhododendron kamchatkensis*), which has miniature red blooms (Sparks 1992).

The magnificent Siberian or Amur Tiger is the largest of all wild cats. Only a few hundred years ago, its realm extended from northern Manchuria west to Lake Baikal and south to North Korea and northeastern China (Matthiessen 2000). Its range shrank over the centuries as a result of hunting, persecution, loss of prey species and habitat. Today it is restricted to the extreme southeastern Maritime Region in the Amur River basin east of Manchuria, west of Sakhalin Island (Miquelle *et al.* 1999). During the 1980s, the Soviet government established a series of reserves for the Tiger, but heavy logging and hunting in the region caused declines in its major prey species, boar and deer. Only 5 percent of the Siberian Tiger's habitat is protected in reserves, according to Evgeny Smirnov, a Russian biologist who studies Tigers (Gourevitch 1995). Moreover, a trade in Tiger bones and other body parts for Traditional Medicine has resulted in the killing, often brutal, of thousands of Tigers throughout their range from India east and south to Indonesia (see Trade chapter).

Siberian Tigers require very large territories. In Sikhote-Alin, their major protected reserve, there are only 10 to 15 resident adults on 400,000 hectares (988,400 acres) (Smirnov and Miquelle 1999). Such large home ranges make them extremely vulnerable to habitat loss, especially the fragmentation of forests by logging. This region™s volcanic peaks rise 5,000 feet from the sea, and forests are crisscrossed by rivers and dotted by lakes. Northern and southern forests meet here, harboring a myriad of tree species. Tall Korean Pines (*Pinus koreansis*) mingle with oaks, maples, walnuts and birches, and unlike the typical Siberian taiga, shrubs and undergrowth are luxuriant (Stewart 1992). These trees reach heights of nearly 150 feet and produce a great volume of cones, providing food for Wild Boar, Brown Bear, Manchurian Moose, and the endemic Ussurian Asiatic Black Bear (*Selenarctos thibetanus ussuricus*). Korean Pines have been so heavily logged outside the reserve that the species is now threatened; although it is protected, illegal logging still occurs (Bohan *et al.* 1996).

A highly unusual type of dark•barked, slow•growing birch grows here. Known as the "Iron Birch" (*Betula schmidtii*), its wood is reputedly so heavy that it sinks in water (Stewart 1992). The Primoryi Province, in which this preserve is located, harbors more than 150 species of trees and shrubs. The meeting of northern and southern forests in this region has resulted in a rich diversity of wildlife. The Ussuri Sika deer (*Cervus nippon hortulorum*) lives alongside the endangered Goral (*Naemorhaedus goral*), a goat•like ungulate native to mountains west to the Himalayas. This is the northern edge of the Leopard's range. The Amur Leopard (*Panthera pardus orientalis*) is a highly endangered subspecies, threatened by both habitat loss and poaching. Lynx and Common Otter are also native. The Dhole (*Cuon alpinus*), a threatened wild dog native to more southerly regions west to India, may also be native to the Sikhote•Alin Preserve. This extraordinarily rich diversity of predators and prey is at great risk from overhunting and logging, however.

As many as 340 species of birds have been recorded in Sikhote•Alin (Stewart 1992), including two endangered waterbirds, the Red-crowned Crane (*Grus japonensis*) and the Oriental White Stork (*Ciconia boyciana*) (Collar *et al.* 1994). A species of ginseng (*Panax ginseng*) grows in the undergrowth and is valued by the indigenous Udege people and others as an invigorating tonic, making it the "root of life" in their folklore. They believe that the ginseng is guarded by the great Siberian Tiger, and shrines are erected to the Tiger, who is believed to possess near•magical powers (Stewart 1992).

In 1991, the Hyundai Corporation of South Korea signed a 30•year contract to cut 500,000 acres of virgin forest on the Pacific slope of the Sikhote•Alin range (Schafer and Hill 1993). By the end of 1992, the area had been clearcut, and Hyundai began logging in the Bikin River Basin, the last pristine river valley in the region (Schafer and Hill 1993). In the Bikin, a small population of Udege live along the river's forested banks, as they have for hundreds of years, subsisting on local wildlife (Schafer and Hill 1993). These people have opposed the entry of the loggers, filing suit to stop the logging, threatening to shoot at logging trucks and removing markers from trees slated for cutting (Schafer and Hill 1993). Their protests succeeded in stopping the logging, negating the original agreement; Hyundai continues, however, to try to gain access to the Bikin forests (Bohan *et al.* 1996). This 600,000-acre watershed of the Bikin River is among the last virgin forests in Ussuria (Matthiessen 2000). A plan by the US Weyerhauser Corporation to cut an area of virgin forests the size of Delaware was thwarted by conservationists, and this forest has been declared a nature preserve (Nunn 1996).

Some 10 million acres of Tiger habitat are being clearcut every year, and members of the Siberian Tiger Project, composed of US and Russian biologists, are proposing alternate methods of timber harvest for the region (Quigley and Hornocker 1994). The native deer and boar, upon which the Tiger depends, are being hunted out of many areas by local villagers and professional poachers, who sell their bones and antlers for the Chinese Traditional Medicine trade. In 1995, the Russian government issued a decree "On Saving the Amur Tiger," which called for a specific plan and schedule to implement Tiger protection efforts (Galster 1996). In response, the Russian-American scientific team formulated a plan the same year to protect all existing Tiger habitat with connected reserves, new national parks, multiple use zones and ecological corridors linking them. It would be the world's largest sanctuary, preserving old-growth Korean Pine and designating various zones in this immense area, which extends from north of Khabarovsk south to Vladivostok in a mosaic of connected land (Galster 1996). The plan also called for a new national Tiger census, which was carried out in early 1996 and found more Tigers than previously assumed, an estimated 330 to 371 animals. The proposed protection plan, when combined with the Bikin traditional reserve and a large region a US government agency is helping to protect through multiple use, would preserve about 26 percent of existing habitat of the 156,000 square kilometers used by Siberian Tigers in Russia (Miquelle *et al.* 1999). The remaining area is either scheduled for logging or agricultural development. The Tiger biologists are urging that all Tiger habitat be included in a national protection plan, as signs of Tigers have been seen in 90 percent of the habitat (Miquelle *et al.* 1999). Coexistence between Tigers and people is essential. This would mean easing human hunting pressure on its prey, primarily Elk and Wild Boar, which have become rare, a major cause for the Tiger™s need of such large territories. Moreover, Tiger poaching needs to be stopped, and Tigers need access to river valleys, which they use for hunting and movements. Most of these have been taken over for human use.

The Siberian Tiger Project was the subject of a 1995 National Geographic film, "Tigers of the Snow," which included the first filming of a baby Siberian Tiger being weighed and examined by biologists in its wild den. The magnificent scenery of this coastal region was filmed from an aircraft, and areas of clearcutting were in stark contrast to the unbroken forests. The film also noted the sad end to a young Tiger hit by a logging truck. These trucks, loaded with giant tree trunks, thunder through the beautiful valleys. The Siberian Tiger Project is the first research study involving radio-tracking ever undertaken of the Siberian Tiger, and it is revealing new information on its range, behavior and habitat needs. Should the reserves be set aside, Siberian Tigers will be the first race or population of Tigers to become stabilized and perhaps increase at a time when all other populations are in drastic decline.

An eloquent book by Peter Matthiessen (2000), *Tigers in the Snow*, focuses on this research and the future of all

Tigers. Anti-poaching work is helping to stem the decline of both the Tiger and its prey, but until its habitat is secure, this once proud cat, master of its domain, will remain beleaguered and under constant threat. Its world has become a battleground, filled with the screeching of power saws destroying the forests it needs to survive, and the constant threat of poachers. As a keystone species at the top of its food chain, the survival of the Tiger is "the best indicator of the health of the ecosystem as a whole" (Matthiessen 2000). Without the Tiger, the deer and boar will become slow, small and overpopulated, destroying their habitat as they have in Europe, where most predators have been eliminated. This is a crucial turning point for the species, whose tropical populations may not survive long. The Siberian Tiger inhabits a world without high human populations, a still-extensive forest habitat, and is the subject of a strong conservation program. The many people who are dedicated to saving it may succeed. In the words of Maurice Hornocker, an overseer of this research project, "One day it will be culturally unacceptable to kill Tigers anywhere for any reason" (Matthiessen 2000).

Eurasian Temperate Forests: Land of the Giant Panda

China's once extensive forests have declined over the centuries as human population increased. In south-central China, temperate forests of many types are watered by the five great rivers of Southeast Asia: the Mekong, Irrawaddy, Yellow, Yangtze and Salween (Mittermeier 1999). This is botanically the richest temperate region in the world, twice the size of California with half of China's plants--12,000 species, of which 3,500 are endemic (Mittermeier 1999). This is the home of the Giant Panda (*Ailuropoda melanoleuca*). Fewer than 1,000 of these black-and-white bears remain in small, scattered populations. When climates were cooler during the Ice Ages 12,000 years ago, Giant Pandas had a far larger distribution, covering much of central and southern China and bordering areas of Burma. As climates warmed and human populations took over much of their habitat, they declined in numbers, and their bamboo forests retreated. Today, Giant Pandas remain only in three provinces, with the largest number in Sichuan. Between 1974 and 1989, their habitat was halved as a result of logging and settlements, from 20,000 square kilometers to 10,000 square kilometers (Mittermeier *et al.* 1999). Satellite studies of their major reserve, Wolong Nature Reserve, found a dramatic decline in forest cover from 1965 to 1997 as growing numbers of people living in the reserve cut deciduous trees and bamboo for firewood (Revkin 2001). During the last decades, with international attention focused on this extremely charismatic animal, reserves have been set aside. Twenty reserves have been established in the remnants of the Giant Panda's habitat, but the species has continued to decline as destruction of forests turn the reserves into islands surrounded by clearcut hillsides. Many Pandas have starved to death when their bamboo forests were cut or underwent a cyclical die-off. Prior to this deforestation, when local bamboo forests died off, Giant Pandas were able to wander widely in search of other bamboo. Their habitat has decreased so much that they are now at the mercy of local conditions within each reserve (Mittermeier 1999 *et al.* 1999).

A long•term study of this species by Dr. George Schaller, of the New York-based Wildlife Conservation Society, arrived at the pessimistic conclusion that the Giant Panda was headed inexorably toward extinction (Schaller 1993). In his 1993 book, *The Last Panda*, Schaller wrote a scathing and unflinching analysis of the failure of existing conservation programs. Among his conclusions was that almost all of the millions of dollars raised around the world to preserve this most popular of all animals had been wasted while wild Giant Panda populations dwindled. His research revealed that Pandas were readily taken into captivity during bamboo die•offs when, in fact, enough bamboo still remained to supply their needs (Schaller 1993). Most of the funds were spent on building dungeon-like breeding and holding compounds rather than on saving its ever•dwindling habitat or hiring wardens to prevent poaching (Schaller 1993). The Wolong Reserve, which covers 780 square miles, was the location of his research area. Wolong had 4,200 people living within its borders in 1989, who were cutting trees and setting snares to kill wildlife for meat, musk and skins (Schaller 1993). In eight years alone, 14 square miles of the Wolong forest were destroyed, and an unknown number of Pandas died in cruel wire snares (Schaller 1993).

Only time will tell whether the urgent habitat and anti•poaching needs of the Giant Panda will be met, or whether

funds meant for its conservation will continue to be spent on breeding compounds. Seventeen forest corridors are planned to link fragmented habitat, but breeding and holding compounds continue to be built, with a goal of 32 stations (Williams 1994). A dedicated Chinese scientist, Pan Wenshi, who has studied these animals for decades, helped save the habitat of some 80 Pandas in these mountains when the high•pitched whining of chain saws was within earshot (Wenshi 1995). The National Geographic Society filmed the mother Panda that Pan Wenshi had studied throughout her life, Jiao Jiao, and her tiny mouse•sized cub when only a few days old (see Video section). This cub, a female he named Xi Wang, meaning Hope, grew into a healthy young Panda and, when four months old, took her first shaky steps out of the warm den (Wenshi 1995). As she grew older, Xi Wang took naps lying on her back in the tops of pine trees, watching her mother as she fed in the forest (Wenshi 1995).

If forest corridors are not soon set aside linking the reserves to one another to allow free movement of Pandas, the species will probably fade gradually to extinction from inbreeding (Lean and Hinrichsen 1992). One source of funding to preserve habitat is the Chinese government loan program, under which Giant Pandas are sent to foreign zoos for periods of up to 10 years. Various zoos in the United States have arranged such loans, paying the Chinese government $1 million per year per zoo, and these funds must be applied to conserving the species in the wild under supervision of the US Fish and Wildlife Service. A pair in the San Diego Zoo produced a healthy female cub in 1999 through artificial insemination. Other pairs were acquired by Zoo Atlanta and the National Zoo in Washington, DC, in 2000. Few Giant Pandas breed naturally in zoos. This funding and the new attention directed at conserving these highly endangered and endearing animals may turn the tide in China to protecting their habitat. If successful, it will also spell survival for thousands of rare Chinese plants and animals that inhabit the Pandas™ forests.

Xi Wang, the Giant Panda studied by Wenshi, inhabits the Qin Ling Mountains, haven for a wide diversity of rare plants. One mountain alone, the 12,359-foot Taibai Mountain, has 150 endemic species of plants, among them the Qin Ling Mountain Fir (*Abies chenensis*) (Ji 1990). Two varieties of this species are listed by the *1997 IUCN Red List Plants* (Walter and Gillett 1998). A neighboring mountain, the Shennongjia, is known as a "Treasure House of Plants" because of the many unusual and ancient species here (Ji 1990). In Hubei Province in the same region is the Dawn Redwood, a deciduous tree which is a close relative of the North American Coast Redwood and Sequoia but far more ancient in lineage (Ji 1990). Until 1941 when a few groves were discovered by Chinese botanists, the Dawn Redwood was known only from Jurassic fossils (MacKinnon 1996). Small populations survive in Sichuan, Hubei and Hunan provinces, but the species is considered Endangered by the International Union for the Conservation of Nature (IUCN) (Walter and Gillett 1998) and only about 1,000 trees may survive in the wild (Dyer 2000). This tree grows to a height of about 115 feet, its delicate pinnate leaves turning golden in the fall. As the sole member of its genus, and a living example of trees that grew in the age of dinosaurs, it is considered a great botanical treasure.

Its seeds have been planted in many parks and botanical gardens around the world. John Williams, the award-winning composer, became fascinated with a Dawn Redwood growing in Boston's Public Garden (Dyer 2000). "It not only looked lovely, but it seemed animate, even intelligent," he said (Dyer 2000). By chance, he met a retired Harvard University botanist, Dr. Siu-Ying Hu, and praised the tree on a walk through the Public Garden. Hu pointed out that he had planted this very tree back in the 1940s, having brought a bag of seeds to America when he arrived from China (Dyer 2000). The Dawn Redwood inspired Williams to compose a musical piece entitled "Tree Song" for harps, keyboards, flutes and delicate percussion. It was performed by the Boston Symphony Orchestra at the opening of the summer concert series at Tanglewood, Massachusetts, in July 2000 and recorded on CD (Dyer 2000).

The extraordinary Dove Tree (*Davidia involucrata*) was named after its discoverer, Pere Armand David, a French missionary who traveled in China in the 19th century and named hundreds of animals and plants. Its white leaves are up to 6 inches long and 3 inches wide, resembling a flock of doves taking flight (Schaller 1993). These trees are quite rare in China, after centuries of deforestation (Walter and Gillett 1998). Even in 1900, when American botanist E.H. Wilson went to China to find seeds from this tree, he traveled six months before he even met someone who had ever seen one (Stocker 1997). When Wilson finally found a Dove Tree, only a stump remained: it had been cut and the wood used to build a house. He later found 10 wild specimens and brought back seed to Harvard University's Arnold Arboretum (Stocker 1997). This species, too, has ancient origins and once dominated prehistoric forests (MacKinnon

1996). Like the Dawn Redwood, it was rescued from extinction and is now cultivated in nurseries and botanical gardens (Stocker 1997).

Many of these plants and trees share the habitat of the Giant Panda, and forest reserves would ensure their survival. A number of endangered mammals that have disappeared from other regions as a result of hunting and habitat loss can be found in Wolong and other Giant Panda Reserves. The Red Panda (*Ailurus fulgens*), thought to be a relative of the Giant Panda, is a rare native, as are the Golden Monkey (*Pygathrix roxellanae*) and the Takin (*Budorcas taxicolor*), a goat•like ungulate. All three are endangered species and declining as the forests are cut. An endangered bird, the Sichuan Partridge (*Arborophila rufipectus*), is restricted to an area of less than 100 square kilometers in south-central Sichuan, where fewer than 2,000 birds survive (BI 2000, Collar *et al.* 1994). Its old-growth broadleaf forest is being felled at a rapid rate, and people enter its habitat to collect bamboo shoots in its breeding season, disturbances that are driving these birds toward extinction (BI 2000). Twenty-six other species of pheasants inhabit this part of south-central China, including the most iridescent birds in the world, the monals. The threatened Chinese Monal (*Lophophorus lhuysii*) inhabits rhododendron and high-altitude coniferous forests and is in decline as a result of logging and hunting, which have been facilitated by the construction of logging roads (BI 2000). The male Chinese Monal has dazzling plumage in an array of emerald green, purple, coppery-golden, purplish-green and white, while the female is more subdued in gray and rufous-brown. The creation of reserves for the Giant Panda have aided this bird's survival, as several are within this bird's range (BI 2000).

China's 25,000 native plant species make up 11.4 percent of the world's plants, including many ancient ones (MacKinnon 1996). The Ginkgo (*Ginkgo biloba*) has been on Earth for 200 million years; this tree grows wild in scattered locations in China, indicating that it was once far more widespread and was eliminated by logging over the centuries (MacKinnon 1996). In prehistoric times, Ginkgoes grew throughout the world but were thought extinct until a few trees were found in remote forests (MacKinnon 1996). Its unusual wide, lobed leaves turn yellow in the fall before falling. This tree has been considered sacred by the Chinese for centuries and is grown in temple gardens and other religious sites. Extracts are sold around the world as an herbal stimulant. In the Himalayas, giant cypresses (*Cupressus*) grow to immense size when protected by Buddhist temples; one specimen measures almost 20 feet in diameter and is estimated to be 2,000 years old (MacKinnon 1996). Entire forests of these giant trees also grew on Taiwan, where only massive stumps remain (MacKinnon 1996). Stephen Spongberg, Curator at the Arnold Arboretum, has studied China's native trees and found numerous species to be extinct in the wild (Stocker 1997). Antique Chinese furniture sought by collectors is often made from the wood of trees that are now extinct, and some trees are so rare that most Chinese botanists have never seen them in the wild (Stocker 1997).

China has more forest types than any country in the world. In the far north, taiga dominates. Conifers, birches and oaks blend into temperate coniferous forests in the northeast. Further south, the Giant Panda's habitat is temperate, evergreen forest. Himalayan forests occur in the west, and in the south, tropical monsoon rainforest prevails (Ji 1990). Unfortunately, very little virgin forests remain in the country, other than in high altitude and remote areas (Ji 1990). In the Giant Panda's highly diverse habitat of south-central China, less than 10 percent of the forests remain in pristine condition (Mittermeier *et al.* 1999). The destruction of these forests has been going on for centuries. During the 19th century, Pere Armand David lamented its destruction:

> *From one year's end to another, one hears the hatchet and the axe cutting the most beautiful trees. The destruction of these primitive forests, of which there are only fragments in all of China, progresses with unfortunate speed. They will never be replaced. With the great trees will disappear a multitude of shrubs and other plants which cannot survive except in their shade; also all the animals, small and large, which need the forest in order to live and perpetuate their species . . . They have the right to life and we annihilate them and brutally make existence impossible for them*
>
> Pere Armand David, 1875

In many parts of China, virtually no natural habitat remains, as centuries of human habitation and agriculture have replaced native vegetation and wildlife. One can travel for 1,500 miles in east•central China, for example, and see a landscape covered entirely with agricultural fields and villages, devoid of wildlife (Schaller 1993). Deforestation caused massive floods in the summer of 1995, when the Yangtze River, the country's longest, flowing from central China east to Shanghai, overflowed its banks. More than l.3 million people were displaced by the flooding, 900,000 houses collapsed, 2.7 million acres of crops were destroyed and 1,200 lives were lost (AP 1995). The economic losses were estimated at $4.4 billion. Each year these floods worsen as development covers the region, removing all natural flood controls (AP 1995). The last forests of any extent in China can be found in the northeast, and in 1987, fires destroyed 18 million acres (an area the size of Scotland) as well as 12 million acres in adjacent Russia (Schaller 1993).

Pere David's Deer (*Elaphurus davidianus*), named for its discoverer, and was once common in the northern forests and marshes. Hunting nearly eliminated the species, and to prevent its extinction, Chinese emperors kept the surviving population in a walled imperial hunting park near Beijing for more than 1,000 years. Even this population was killed by soldiers and villagers in the 1900 Boxer Rebellion, however; fortunately, some had been taken to England and kept by the Duke of Bedford on his estate (Schaller 1993). In 1985, 22 of these deer were returned from captive populations to the same walled park in China, now reduced from 150 square miles to 440 acres (Schaller 1993). Several other herds have been reintroduced elsewhere in China, numbering some 600 animals (MacKinnon 1996).

Reverence for nature in China dates back many thousands of years and is an integral part of the culture of this ancient country. It may now be reemerging. The 1979 Forest Law contained strict regulations on logging and required 40 percent forest cover in the mountains and 30 percent nationwide. This was strengthened in 1988 with a ban on logging in Yunnan and Sichuan, and legal protection was accorded to 389 plant and 206 animal species (Geatz 1999, Mittermeier *et al.* 1999). Reserves are being set aside throughout the country, increasing from 44 in 1956 to 600 in 1991, with a goal of 800 reserves protecting 5 percent of the country (Schaller 1993). This is indeed laudable in the most populous country on earth, and this eleventh-hour commitment is preserving many remnants of the once diverse and abundant natural heritage.

In practice, however, logging and firewood cutting tend to far exceed reforestation or preservation of forests in reserves or parks. Heavy livestock grazing by herders, who also clear forests for pasture, is devastating delicate forest habitats (Mittermeier *et al.* 1999). Logging trucks carrying the trunks of the last remaining stands of old-growth forest can be seen in many areas. These deforested areas do not tend to regenerate because fires and grazing by goats kill the saplings (Mittermeier *et al.* 1999). During the late 1990s, The Nature Conservancy began a major project to study the biodiversity of the southern province of Yunnan, whose ecosystems range from alpine to subtropical forest (Geatz 1999). Certain tribes of this region have a strong tradition of conservation, and the provincial government has welcomed the help of this organization in helping to protect their natural heritage. Its 2000 report, "Conservation and Development Master Plan for Northwest Yunnan," includes recommendations for the protection of biodiversity, regional planning and resource development to provide ideas for non-destructive economic projects, such as growing plants for medicinal and ornamental purposes as an export commodity and developing ecotourism for this spectacular region (Geatz 1999, The Nature Conservancy 2000).

The future of China's forests and its tremendous biological diversity are greatly affected by its enormous human population of more than 1.2 billion people, whose growing needs encourage heavy hunting of its depleted deer and ungulate populations and large livestock herds, as well as excessive tree cutting for firewood (Mittermeier *et al.* 1999). Various international conservation organizations are working to help China in assessing its diversity and the threats to it, and to encourage enforcement of its 1982 Constitution, which states that the nation must protect and improve its environment and ecosystems, prevent pollution and protect precious animals and plants (Mittermeier *et al.* 1999).

Asia's beautiful pheasants and partridges are disappearing rapidly as their forests are cut and many are hunted for

meat. Partridges and pheasants are found from the Himalayas to sea level tropical forests throughout most of Asia. They have declined dramatically, however. Of 22 species of Asian partridges, 15 species, or 68 percent, are listed by BirdLife International in *Birds to Watch 2: The World List of Threatened Birds* (Collar *et al.* 1994). An even higher degree of threat is suffered by the many spectacular pheasants. Of the 52 species of Asian pheasants, 38 species, or 73 percent, are threatened by the destruction of forests and hunting by the same authorities (Collar *et al.* 1994). Some endangered Himalayan pheasants include the Tibetan Eared Pheasant (*Crossoptilon harmani*), White Eared-pheasant (*Crossoptilon crossoptilon*), Cheer Pheasant (*Catreus wallichi*) and Elliot's Pheasant (*Syrmaticus ellioti*) (Collar *et al.* 1994). They show a great variety in their colorful and iridescent plumages, rivaling birds-of-paradise in beauty. Their relatively large size and brilliant plumage make them vulnerable to hunters, and they have not been studied intensively in the wild to determine habitat size and other requirements for their survival. Very few species have been protected in parks and reserves.

The mixed hardwood forests that once cloaked the Himalayas, studded in many areas by native rhododendrons, have been decimated during this century. Some 57 Asian rhododendrons are listed by the *1997 IUCN Red List Plants*. The deforested steep slopes are now prone to erosion by the monsoon rains that arrive annually. Heavy rains bring huge landslides and floods. Tree cutting, primarily by people gathering firewood or clearing land for agriculture, has been particularly severe in the Indian, Pakistani and Nepalese Himalayas. The once unbroken stands of oak and pine have become fragmented and totally absent in many areas. Human populations have risen over the past century to levels far above carrying capacity of this delicate region.

The Ganges River, which flooded only once every 50 years prior to deforestation, now floods every few years since the Himalayan forests that retained the water throughout the years have been logged (Lean and Hinrichsen 1992). Only Bhutan has preserved the majority of its forests, which are crucial to the survival of many species extinct elsewhere in the Himalayas. Tigers, Asian Black Bears, Himalayan Tahr (*Hemitragus hemlahicus*), Red Pandas, Golden Leaf Monkeys (*Trachypithecus geei*), and Tibetan Macaques (*Macaca thibetana*) are among the many mammals endangered by the loss of Himalayan forests. The Woolly Flying Squirrel (*Eupetaurus cinereus*), the largest squirrel species in the world, has just been rediscovered in northern Pakistan after being thought extinct for 70 years (Walters 1995). Four feet from its nose to the end of its tail, this squirrel may be able to glide distances of up to 1,000 feet (Walters 1995). Peter Zahler, a Cornell University zoologist, traveled to Pakistan in 1994. In a remote valley where this squirrel was rumored to exist, a local villager, who found one in a mountain cave, supplied a live animal in a bag. Zahler studied it for a short time, photographed and measured it, and then hiked 3 hours up the mountain and released the squirrel at its capture site (Walters 1995). This squirrel has been designated Endangered by the *1996 IUCN Red List Animals*. This exciting rediscovery is tempered by the threats from deforestation and overgrazing in its mountain habitat. Local people report that it is solitary and active throughout the year, climbing conifer trees to feed (Nowak 1999). The Woolly Flying Squirrel is not hunted, but the conifers on which it depends are being cut at a great rate, causing it to decline over the past decade (Nowak 1999). Its total population is estimated at fewer than 2,500 and falling as a result of habitat loss (Nowak 1999). (Photos of this squirrel appear in Nowak 1999.)

Eurasian Temperate Forests: Lost Forests of the Mediterranean and Europe

Forests of towering cedars, oaks, firs, pine and beech once blanketed the region surrounding the Mediterranean Sea. Wildlife abounded in these primeval forests. Some 8,000 years ago, forest cutting began (Mittermeier *et al.* 1999a). Livestock gradually replaced wildlife, stripping the vegetation. In 3,000 B.C., Phoenicians logged the great forests of Cedars of Lebanon (*Cedrus libani*) for ship and building construction to trade with Egyptians and other cultures (Mittermeier *et al.* 1999). These massive trees reach 130 feet in height and are among the most majestic and stately of all trees. On the island of Cyprus, an endemic cedar, the Cyprian Cedar (*Cedrus brevifolia*), covered the

island. Centuries of tree cutting and livestock overgrazing have reduced this tree to a relict population. Other forests on the Mediterranean's eastern shores were felled for building and to clear land for agriculture and grazing. The Greeks cut their forests in spite of warnings by the philosopher Plato as early as 4,000 B.C. that water supplies and wildlife would disappear (Pontiff 1991). The country's climate grew dryer and its topsoil washed into the sea (Runnels 1995).

Italy's southern forests were cut in Roman times, but north of the Adriatic Ocean, large expanses of beech and oak forests remained intact until the 16th century when they became the raw material for ships and galleys that sailed the Mediterranean waging battles and trading. Enormous amounts of lumber were needed to build these ships. When an exact replica of a galley was reconstructed a few years ago, 650 mature trees were required: 50 beech trees were needed for oars, 300 pines and firs for planks and spars, and 300 mature oaks for hull timbers (Attenborough 1987). In 1571, Venetian fleets battled the Turkish fleet which had been attacking and looting their ships. The 500 vessels in the Venetian and Turkish fleets had required the felling of more than a quarter-million mature trees (Attenborough 1987). Soon thereafter, the building of Venetian galleys came to an end for lack of trees, and shipbuilding moved elsewhere in Europe where trees were still abundant (Attenborough 1987). A single forest resembling the original beech and evergreen forest remains intact near the Adriatic in the former Yugoslavia. Its beauty was filmed for the series, fiThe First Eden. The Mediterranean World and Manfl (see Video section, Regional, Mediterranean).

Hardwood forests covered much of Spain until the early 16th century when, by royal decree, it was decided that the economy of the country could be expanded by developing a Spanish monopoly on the breeding of Merino sheep for their valuable wool (Attenborough 1987). Sheep herds became larger and larger, and forests were cut to provide grazing land. Within decades, the forests that had covered central Spain were gone, and topsoil had eroded, leaving shrubland (Attenborough 1987). These forests have not regenerated. Some oak forests have survived in parts of Spain, but intact ecosystems with native ungulates and predators have disappeared. Livestock grazes in all but the most remote areas. The few remaining Gray Wolves, as well as the endemic Iberian Lynx (*Felis pardina*), are critically endangered due to loss of forests and persecution. As an indication of the degradation of habitat, many species of Spanish wildlife are threatened with extinction. Worldwide, about 11 percent of the world's birds are threatened with extinction (Collar *et al.* 1994), but 37 percent of Spain's birds are threatened, 53 percent of its mammals, 41 percent of its reptiles, and 45 percent of its amphibians (Peters and Lovejoy 1990).

Forests of pine, cedars and oaks blanketed the slopes of the Atlas Mountains of Algeria and Morocco prior to the Roman conquest. Logging by the Romans and people in the intervening centuries has destroyed all but fragments of these forests. The Atlas Bear (*Ursus arctos crowtheri*) originally ranged in these forests but was gradually pushed toward extinction by loss of its forest habitat, hunting and capture. The last of these bears was killed in the late 19th century (Day 1981). The endemic Atlas Cedar (*Cedrus atlantica*) has wide girths and grows to heights of more than 125 feet. They are often covered in moss and lichens in the cool altitudes (color photo, see Mittermeier *et al.* 1999a). Unfortunately, they are fast being depleted by timber cutters in Morocco and Algeria (Mittermeier *et al.* 1999a). North Africa's forests have become fragmented by centuries of logging and heavy grazing by cattle, sheep, and goats. The native Wild Boar (*Sus scrofa*) have also been extremely destructive to the few forests that remain, endangering many birds (Collar and Stuart 1985).

Surprisingly, a bird species native to the Atlas Mountain forests remained unknown until 1975. The Algerian Nuthatch (*Sitta ledanti*), a small, buffy songbird with white eyebrows, was discovered in a national park on Mont Babor (Collar and Stuart 1985). Even in national parks in this region, however, livestock are permitted to graze, consuming young trees and other vegetation. After conservationists protested that this little bird's entire habitat would be eliminated if livestock were not excluded, sheep and goats-- but not cattle--were banned from the park in 1981. To prevent forest cutting by the local people, propane gas has been supplied to use as fuel for cooking and heat (Collar and Stuart 1985). The forest on Mont Babor consists of mixed Atlas oak, Atlas Cedar and the Algerian Fir (*Abies numidica*), a threatened species which grows only on this mountain (Walter and Gillett 1998). The Algerian Nuthatch uses cedars, oaks and, especially, the Algerian Fir for seeds and nesting (Harrap and Quinn 1995). The population of about 80 pairs of Algerian Nuthatches censused in Mont Babor National Park in the early 1980s remained constant,

and in 1989, a second population of about 350 birds was discovered in a nearby oak forest within the Taza National Park (Collar *et al.* 1994). Even though the Taza has National Park status, conservation of the forest has been hindered by cattle grazing that prevents tree regeneration. Also, wood-cutting is allowed that removes potential nest sites, and fires are set, killing many types of animals (Harrap and Quinn 1995). These birds also survive in two small isolated tracts of unprotected, degenerating forest 30 kilometers away, but the total population probably does not exceed 1,000 birds (BI 2000).

Another rare animal, the Barbary Deer (*Cervus elaphus barbarus*), barely clings to life in the disappearing Algerian forests. It is now extinct in Morocco and survives only in a small forest of cork oak and pine on the border between Tunisia and Algeria. They number only a few hundred, including a captive population, and are declining each year. This subspecies of the European Red Deer is listed as Endangered onthe US Endangered Species Act.

Israel has reintroduced related subspecies of some wildlife that have become extinct, bringing in closely related races of gazelles, wild goats, wild asses and Ostriches. The forests, however, are unlikely to return. The vegetation surrounding the Mediterranean today is dominated by shrubland that can regenerate after frequent burning (Mittermeier *et al.* 1999a). Livestock in vast numbers consume tree saplings and pull plants out by the roots. Goats are able to climb low bushes and graze their tops. The soil structure is very loose and alkaline, and the nutrients have been leached out by thousands of years of cultivation, overgrazing and erosion. Only plants that survive in arid climates on poor soil, such as succulents, annuals and those that regenerate from roots, can grow here (Peters and Lovejoy 1990). In many areas, exotic species, such as American prickly pears and Australian eucalyptus, have taken over as a result of the impoverished soil. The remaining bits of forest in southeastern Spain, Morocco, Algeria, Syria and Israel are being cut for fuel at a rate of 14 percent per year (Peters and Lovejoy 1990). The net result of the widespread loss of forests in the Mediterranean is that only about 1 to 2 percent of pristine, original forest remained at the end of the 20th century, all in small fragments surrounded by farmed and developed land (Mittermeier *et al.* 1999a).

The transitions that brought about the present state of affairs occurred over many centuries. So gradual was the environmental deterioration that one generation of people was usually unaware of the ecological changes wrought by previous generations. Once the forests were lost, succeeding generations may have been unaware that they had ever existed. Whether any progress can be made in regenerating forests by bringing in topsoil and replanting in protected areas will depend on the concerns and will of the people of the Mediterranean, who number more than 300 million (Peters and Lovejoy 1990).

North of the Mediterranean, vast forests covering most of Western Europe remained until a few hundred years ago. Deciduous and mixed pine forests were logged over the centuries near towns and cites, and the forests retreated, replaced by agriculture and grazing land. By the 18th century, 90 percent of the forests had disappeared. In Scandinavia, Germany, Austria and Switzerland, tree farms have taken the place of natural forests. Man-made hallmarks of civilization now cover northern Europe except for a few isolated pockets of original virgin forest. Along with these forests, went the Auroch (*Bos primagenius*), an immense wild cow that became extinct in the 17th century. The large predators, Gray Wolves, Lynx and Brown Bears, that preyed on deer, elk and European Bison (*Bison bonasus*) were persecuted to near extinction and remain very rare. The largest remnant of these once vast forests is Bialowieza, on the Polish-Belarus border. It harbors the last herd of free-ranging European Bison and a small number of Gray Wolves.

An organization to protect these wolves, The Association for Nature "Wolf" is also concerned about the cutting of the old-growth trees in Bialowieza Primitive Forest, of which only 22 percent is protected in Poland (Nowak and Myslajek 1999). The "Wolf" organization is working to stop logging and protect this forest for future generations by the creation of a transnational park with Belarus (Nowak and Myslajek 1999). As the top predator in this and other forests of Poland and other European countries, the Grey Wolf helps maintain the health of the forest and cull overpopulations of hoofed animals such as deer. *Wolfnet*, the bulletin published by The Association for Nature "Wolf," is helping to educate the public about this maligned animal, which is often killed on sight in Europe. The

organization is also sponsoring studies of the estimated 500 wolves in Poland and training livestock owners in the use of guard dogs to protect sheep (Nowak and Myslajek 1999).

Eurasia's northern boreal forests, or taiga, are far more extensive than North America's, stretching 6,000 miles from the Atlantic coast of Norway east to the Sea of Okhotsk on the Pacific rim (Sparks 1992). The western section in Scandinavia is almost gone: more than 90 percent of the taiga in the Scandinavian peninsula has been replaced by tree farms, which support almost no wildlife (Walsh 1995). Norway has lost 100 percent of its natural forests, and Sweden and Finland nearly all of theirs (Walsh 1995). The result of this destruction has been a crash in forest biodiversity and declines in many forest species. Seventy•three species of birds are declining or vulnerable in this region, including the Siberian Jay (*Perisoreus infaustus*) and White•backed Woodpecker (*Dendrocopos leucotos*) (Walsh 1995). Sweden's tree farms have replaced more than 200 species of plants and animals, and 800 species are rare or declining, as reported in *Taiga News: Newsletter on Boreal Forests* in 1992. The same publication noted that 805 species are endangered from clearcutting old-growth forests in Finland, and conservation groups have formed to try to save them from corporate logging. The Russian portion of taiga forest, which makes up the majority of these forests, has been less damaged, but with the fall of the Soviet Union, forests are now open to international lumber companies. Much of this forest is so remote that it may never be logged, but millions of acres are likely to be leveled over the next century.

Temperate Rainforests of the Southern Hemisphere

South of the Equator, in widely separated areas, are remnants of forests with species of trees older than the dinosaurs. These temperate rainforests grow in southern Chile and Argentina and, far to the west, in New Zealand, eastern Australia and the islands of Norfolk and New Caledonia. They have been growing nearly undisturbed for more than 100 million years, and many species of animals native to them have ancient lineages as well. Giant beeches grow in southern South America as well as far away in southern New Zealand and Australia. All these trees once grew on the southern supercontinent, Gondwana, some 160 million years ago. New Zealand, Australia and South America were joined and these trees were part of vast primitive forests. The continent gradually broke apart. Many species of trees survived on these new continents and islands as long as they could adapt to the new climates of the different latitudes and longitudes, where they were pushed by continental drift through movements of the Earth's tectonic plates. In spite of eons of dramatic changes on Earth, geological and climatic, large fragments of these ancient forests have survived to the 21st century, only to face possible extinction. The wildlife now inhabiting them is predominated by more recently evolved species which coexist with species whose ancestors inhabited Gondwana. These fragile and unique ecosystems have undergone radical changes over the past few centuries, and many have been logged and cleared, with serious consequences for the native wild animals and plants.

South America

Only a century ago, South America's primitive forests blanketed the entire region from the southern tip of the continent north half the length of Chile's coast and eastward into Argentina's Patagonia. Beech trees of the genus *Nothofagus* covered most of the region, mixed with evergreen and various deciduous trees. Once extending more than 35 million acres, these forests comprised the largest stands of pristine temperate rainforest in the world (Nash 1994). *Nothofagus* beeches are among the most ancient species of trees and have been on Earth more than 150 million years. Soon after their arrival in the 16th century, European settlers began logging these forests, but not until the 20th century did widespread clearance begin. During the 1940s and 1950s, some 13,000 square miles, or 8.3 million acres, of these beech forests were cleared and burned for cattle ranching. Commercial logging continued, subsidized by the Chilean government, which spent comparatively little on forest conservation (Sims 1995). These beautiful forests

have been cut mainly for wood chipping factories that produce paper pulp for export to Japan. Powerful commercial lobbyists have opposed legislation to protect the portions of these forests that remain, enabling logging companies to continue clearcutting, pushing some species to the brink of extinction. Once logged, the land is replanted with plantations of eucalyptus or pine, or turned into pastureland for livestock. The *1997 IUCN Red List Plants* lists four species of *Nothofagus* native to Chile and Argentina as vulnerable, indicating a decline toward Endangered status that, if not reversed, will result in their extinction (Walter and Gillett 1998).

Not all Chilean government officials are proponents of the logging. Carlos Ritter, head of the technical department for the National Forest Corporation, a government entity, complained: "Japan has fomented the cutting of our native forests, but they try not to assume responsibility. They say they are only buying the wood. But they have created so much demand the peasant farmer cannot resist cutting his forest" (Nash 1994). During the 1990s, an American logging firm, the Trillium Company, purchased 632,000 acres, or 987 square miles, of ancient forest in the southernmost region, Tierra del Fuego (Sims 1995). The Chilean government overruled opposition and gave permission to the company to begin logging in mid-1996.

An American conservationist, Douglas Tompkins, has preserved some of these forests. He purchased 741,000 acres in the southern province of Palena with more than $12 million from his clothing chain, Esprit. The cost of these beautiful forests, at $17 per acre, was miniscule in comparison to the cost of preserving temperate rainforests in the United States. Save•the•Redwoods League, an American conservation organization founded in 1918, recently celebrated its 75th anniversary, having spent $73 million to save 260,000 acres (about one•third of Tompkins™ acquisitions in Chile) of Coastal Redwoods at an average price of $280 per acre (National Geographic Society 1993). Most of the acreage of American old-growth redwoods that has been saved was purchased decades ago, and today it is worth hundreds of thousands of dollars per acre. The timber saved by the Save-the-Redwoods League is worth more than $5 billion (National Geographic Society 1993).

Tompkins' land includes South America's largest block of virgin temperate rainforest, protecting 78 percent of the remaining old-growth rainforest in Chile, including the country's largest remaining virgin stands of Chilean Larch or Alerce (*Fitzroya cuppressoides*) (Bowermaster 1995). This endemic and ancient tree grows to heights rivaling North American Coast Redwoods, with girths nearly as great as Sequoias (*Sequoia dendron*) (Dorst 1967, Walter and Gillett 1998). These majestic trees can live up to 4,000 years and take 500 years to reach commercial size. Extremely slow to reproduce, Alerces do not produce seed until 200 years of age. Like redwoods, they are highly coveted for their lumber and have been cut with little regard to conservation. Highly endangered in Argentina and Chile (Walter and Gillett 1998), few groves of these trees remain, and although officially protected, they are sometimes illegally cut for the international timber market.

Tomkins came under attack by Chilean politicians and leaders of the Catholic Church who questioned his motives in purchasing such a large area and objected to his organization, the Foundation for Deep Ecology, for its statements about the importance of birth control to prevent human overpopulation (Sims 1995). Others falsely accused him of razing forests, setting up a nuclear dump, promoting abortion and even importing Israeli commandos. Many objected to private ownership of extensive areas of land by foreigners or disliked the idea of large-scale land preservation, but a Chilean conservation organization, the National Committee for the Defense of Fauna and Flora, rallied to his defense. After much contention, the Government of Chile accepted Tompkins' gift of 677,000 acres as a park in July 1997 (Grove 1999). It is known as Pumalin National Park and is considered one of the most ecologically important national parks in South America.

In an ominous note, part of the agreement with the Chilean government allowed access to the park by mining companies. The forest will not be logged, and there are plans for tourist accommodations and trails for hiking. This land is spectacularly beautiful, with glacial lakes and waterfalls, bisected by pristine rivers, its ancient forests teeming with wildlife. Covering the entire width of Chile, it borders a magnificent coastline with abundant marine mammals and sea birds. If preserved with care, the park will prevent the extinction of Chilean Larch and at least a portion of the magnificent southern beech forests which have been destroyed elsewhere. Ecotourism is being developed in the park

area on a very small scale, with rustic accommodations, and tours from the United States and elsewhere are now visiting the park regularly. Not far to the north, the Parque Nacional Huerquehue preserves some of the magnificent scenery of this region. Known as the Lake District, portions of old-growth rainforest are protected in a landscape of crystalline lakes, waterfalls and churning rivers.

Another tree that survives from the Jurassic, the Monkey Puzzle Tree (*Araucaria imbricata*), has a somewhat larger range in South America. It is a member of a family of primitive conifers, the Araucaria, that grew on Gondwana. Monkey Puzzle Trees are being logged for timber and displaced by development, cattle ranches and mines. Named for their dense and interwoven crowns said to puzzle monkeys climbing them, the wide, unbranched trunk is covered in leathery bark in a knobby, diamond-shaped pattern. The nuts produced by these trees have been prized by the native Malpuche people for thousands of years. Malpuche means "People of the Monkey Puzzle Tree," and traditionally they did not overexploit these trees. Commercial exploitation of the nuts in local markets is threatening the species by leaving too few seeds for regeneration. Extracts from the Monkey Puzzle Trees have shown promise as a birth control drug, a traditional use by native peoples.

Like the Alerce, Monkey Puzzle Trees live to be very old, at least 1,300 years, and trees of the Araucaria family are considered the progenitor of all pines (Grove 1999). (See photographs in Grove 1999, and Dorst 1967.) When the Discovery Channel-BBC producers of the documentary film, fiWalking With Dinosaurs,fl searched for living landscapes in which to place their animated dinosaur models, an open forest of Araucaria trees in Chile was selected as an authentic backdrop, having changed little since dinosaurs fed on their crowns. The book based on this film has photographs of Araucaria forests from the movie (Haines 1999). Thirty-eight species of Araucaria survive, distributed in South America, New Zealand, Fiji, New Caledonia, Australia and Norfolk Island north to Malaysia. More than three-fourths of these, 30 species, are threatened with extinction, according to the *1997 IUCN Red List Plants* (Walter and Gillett 1998).

Another family of trees dating back to Gondwana, the podocarps, are also extremely primitive evergreens. Podocarps often have straight, unbranched trunks and clumps of dense needles near the trunk. Like the Araucaria, many of the species in the family are in decline: of 125 species worldwide, 70 are threatened (Walter and Gillett 1998). Two of these inhabit the southern rainforests of Chile and Argentina, and others survive in more tropical climates in Venezuela, Bolivia and Brazil, Madagascar, New Caledonia, Fiji, New Guinea and Malaysia. Australia and New Zealand have more temperate climates and many native podocarps.

A threatened bird native to the old-growth forests of Chile and southern Argentina is the Slender-billed Parakeet (*Enicognathus leptorhynchus*), one of the few members of the parrot family that can survive cold climates. It has undergone steep declines in recent years as a result of forest clearance (Forshaw 1989). At least 22 bird species are restricted to Chilean *Nothofagus* forests, making this region a center of endemism (Cracraft 1985).

The most endangered denizen of southern rainforests may be the South Andean Huemul (*Hippocamelus bisulcus*), a short•legged, stocky deer that once lived throughout this habitat in Chile and Argentina. Driven from most of its haunts by the introduction of European deer, cattle ranching, logging and hunting, they now survive only in the extreme south of Chile, in tundra•like terrain with elfin woodlands. Low, gnarled trees are whipped by the strong ocean winds from Antarctic regions (Dorst 1967). No more than 1,300 South Andean Huemul are thought to remain (Nowak 1999), and a campaign has been launched to save these deer (Stutzin 1995). The National Committee for the Defense of Fauna and Flora and the Frankfurt Zoological Society are researching their status and raising money to purchase sufficient habitat for their survival (Stutzin 1995). Two reserves protect about 100 Huemul, but as the target of meat poachers throughout their range, they are found only in inaccessible areas. Researchers studying these deer, which had never had contact with humans, found them completely unafraid, grazing and bedding down within feet of their tents. This tameness makes them especially vulnerable to poachers.

Without immediate habitat protection and guarding of the remaining deer, the Huemul may not last long. Their status has declined even in national parks within the past few years. Alejandro Frid, a biologist who found these deer

living in pristine habitat along a fjord in extreme southern Chile in a 1990 study, returned in 1995 to find near-disaster. Cattle had been set free in the Bernardo O'Higgins National Park, displacing the Huemul from their prime grassland habitat and forcing them into the sparse vegetation of the uplands (Frid 1997). He was told by a local ex-poacher that illegal hunting by local fishermen still occurred, and the lowland habitat was so trampled by the cattle that it was covered in muddy pits (Frid 1997). Ironically, the owners of the cattle did not eat beef but were adopting European cultural traditions, and since this harsh region did not provide good habitat, the cattle were not in good condition (Frid 1997). Conservationists are working to have the cattle removed from the national park, and international organizations are working to protect remnant populations of these deer. On the Straits of Magellan, where other South Andean Huemuls survive, commercial logging corporations are clearing forests (Frid 1997). The introduced Elk (*Cervus elaphus*) competes for habitat, and many Huemul are killed in attacks by domestic dogs (Nowak 1999). The South Andean Huemul and its close relative the North Andean Huemul (*Hippocamelus antisensis*) are both listed as Endangered on the US Endangered Species Act. This listing may not prevent their extinction, however.

The world's smallest deer, the Southern Pudu (*Pudu puda*), also inhabits southern temperate rainforests. This dog-sized deer is short-legged, with thick, buffy, reddish-brown fur and small, spike-like antlers. It is so diminutive, weighing only 5.8 to 13.4 kilos (Nowak 1999), that people have captured them as pets, which has contributed to their rarity. Its range within Chile was once far more extensive (Nowak 1999). The major threat to this species and its close relative, the Northern Pudu (*Pudu mephistophiles*) of the Andes of Peru through Colombia, is forest destruction. *Pudu puda* is listed as endangered on the US Endangered Species Act and on Appendix I of CITES, banning commercial trade, but hunting still threatens it.*

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*Many trees of the southern beech forest, the South Andean Huemul and Pudu deer appeared in the 1997 film, fiChile, Land of Extremesfl (see Video, Central and South America section); the trees were photographed in *Living Planet, Preserving Edens of the Earth* (Grove 1999).

New Zealand

New Zealand was formed some 80 million years ago when it broke off from the tropical southern continent, Gondwana (Molloy 1994). The land mass moved away with resident pterosaurs, sauropod and carnosaur dinosaurs, along with primitive frogs, lizards, land snails, spiders and other insects and invertebrates. It is also possible that the ancestors of the flightless moas and kiwis were present on Gondwana (Heather and Robertson 1997).

Unlike South America, New Zealand remained uninhabited by humans until a thousand years ago, allowing an extraordinary fauna and flora to evolve. Giant trees of many types, some almost as massive as sequoias and others rivaling American Coast Redwood in height, thrived in primeval rainforests and swamps. The dinosaurs died off 65 million years ago simultaneous with their extinction elsewhere in the world. Over the eons, as the land moved southward, the climate cooled. Many tropical species, unable to adapt, died out, while others coexisted with immigrant species of plants, birds and insects that arrived by wind or ocean current. Geological and climatic events--from earthquakes and mountain uplifts caused by movements in the Earth's plates, to the weathering of wind, sun and rain--produced great changes in the topography over the millennia. The original land mass split into two main islands and many satellite islands, and snow-capped mountains rose on the southern island. Ice Age glaciations occurred during the Pleistocene between 2.4 million years and 10,000 years ago (Molloy 1994). These cold periods did not, however, eliminate the majority of ancient plant or animal species, another proof of their amazing adaptability.

When the Polynesian Maori people arrived about 1,000 A.D., temperate rainforests with understories of giant tree ferns grew throughout the island's swamps, lowlands and highlands, over 80 percent of the land. The Maori must have been stunned to see thousands of flightless birds of various sizes roaming the island. The moas had evolved from a single ancestor into some 11 species which grazed in herds or in small groups. Following the extinctions of the dinosaurs, moas evolved in a wide range of species able to browse vegetation in forest, shrubland and grassland habitats (Molloy 1994). The native plants developed thorns and other means of defense against the moas. These plant adaptations persist today, long after the disappearance of the moas, remnants of a bizarre and fascinating ecosystem. These emu-like birds ranged from chicken-sized to a species 10 feet or more in height, the tallest bird that ever lived. With heads disproportionately small and necks long and gangly, these down-covered birds walked about on thick, scaly legs. Also resident on the islands was a massive eagle, weighing up to 29 pounds (Molloy 1994). This giant bird of prey was the largest eagle to have ever lived on Earth and may have preyed on moas or soared about in search of moa carrion.

On the southern island, penguins lived on rocky coasts and in wet coastal rainforests; one species was a giant, standing more than 5 feet tall (Molloy 1994). No mammals other than bats were native. Lizards called tuataras, older than dinosaurs, lived in many habitats on the islands. Primitive and unusual frogs of types long extinct elsewhere were abundant, especially in mossy rainforests. Huge, cricket-like wetas, insects virtually unchanged for 200 million years, had evolved into 70 species. Compared to grasshoppers, wetas have heavy bodies, weighing as much as 2.5 ounces. Scurrying about at night, their diet and behavior are rodent-like. They are considered by zoologists to be among the most interesting animals on the islands (Molloy 1994).

The forests were dominated by trees very little changed since the age of the dinosaurs. Three major groups of trees, all evergreens, dominated New Zealand's forests, survivors of the Cretaceous Era 135 million years ago: araucaria, podocarps and southern beeches. All had close relatives in South America and other parts of the world.

A single species of the Araucaria family, to which the South American Monkey Puzzle Tree belongs, dominated forests on North Island. The enormous Kauri (*Agathis australis*) has a massive, wide trunk that rises to great heights before branching in a wide canopy. Its gray, grainy bark forms deep, vertical ridges that curve upward, wrapping around the tree as it rises hundreds of feet into the air. Verdant tree ferns, with large, short trunks, and primitive club mosses form an understory beneath them.

Seventeen species of podocarp trees survive in New Zealand, some of which reach great heights. New Zealand's tallest tree is the Kahikatea (*Dacrycarpus dacrydioides*), or New Zealand Cedar, a type of podocarp which is nearly as tall as Coast Redwoods but with a slimmer trunk, often covered in epiphytic plants (Molloy 1994). Podocarp forests were once very widespread throughout both North and South Islands, each species in a slightly different habitat (Molloy 1994). At the other extreme is the world's smallest conifer, the ankle-high Pygmy Pine (*Lepidothamnus laxifolius*), a podocarp growing at high altitudes in a beautiful area known as the Southern Alps on South Island (Molloy 1994). Another podocarp type, the Celery Pines (*Phyllocladus spp*), are small trees whose leaves are actually flattened stems. One podocarp, *Halocarpus kirkii*, is listed as Threatened by the International Union for the Conservation of Nature (IUCN) (Walter and Gillett 1998), and all have declined dramatically in range.

Southern beeches of *Nothofagus*, the same genus as those in South America, once blanketed South Island in dense, canopied forests, often without an understory of plants other than low ferns (Molloy 1994). Today some forests remain, growing in association with broadleafed trees and hardwoods that arrived in New Zealand at a more recent time (Molloy 1994).

Some extremely primitive plants have also survived in New Zealand. The largest moss in the world (*Dawsonia superba*), giant liverworts, clubmosses and horsetails are among these (Molloy 1994). *Tmesipteris*, an epiphyte, is a relict of the earliest vascular plants, which evolved some 400 million years ago. This rootless plant clings to the branches of trees and hangs in vine-like, leafy strings. New Zealand's forest floor plants, a micro-world of species, most of which are less than an inch high, are beautifully photographed and described in *The Forest Carpet* by Bill and

Nancy Malcolm (1989), a book devoted to New Zealand's mosses and related plants.

Other survivors from Gondwana include an extremely ancient family of spiders, Archaeidae. First described from a specimen frozen in amber several million years old, seven species have been found on Madagascar, also a part of Gondwana: one in South Africa, three in Australia, five in New Zealand and one at the tip of South America (Preston-Mafham 1991). The Archaeidae spiders have strange, grotesquely shaped bodies, visible only through a microscope since they are only 0.14 inches long; they live among leaf litter on the ground (Preston-Mafham 1991).

The beauty and primitive auras of many of the Kauri, beech, podocarp forests and pristine forest swamps evoke a "bygone era when dinosaurs still roamed the Earth" (Molloy 1994).* Beech and podocarpus forests cover South Island's Fiordland, a region along the southeastern coast resembling Norway's fiords, with inlets penetrating deep inland, lined by misty forests. The trees are buffeted by fierce winds from the west that bring rainfall of up to 20 feet a year. In this rugged wilderness, mosses and huge tree ferns thrive in the dampness.

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*Many of the primitive landscapes that survive in New Zealand were captured in Gerald Cubitt's photos in *Wild New Zealand,* accompanied by natural history information in the text by Les Molloy (1994). Also, two films, fiLand of the Kiwifl and fiMountains of Water,fl described in the Video section, display these vistas.

The moas, which must have been very tame and unafraid, were hunted by the Maoris, who lived on their meat and eggs for centuries. The last of the moas, all smaller species, are said by some authorities to have survived until the 18th and 19th centuries (Greenway 1967), although this is disputed by others who assert that the moas were killed off well before the 15th century (BI 2000). Some Europeans claimed to have seen living moas, but no account was ever confirmed. Millions of their bones and eggs, and a few examples of skin, are all that now remain of these birds. The giant penguin, giant eagle and many flightless birds were also wiped out, apparently by hunting. European settlers eliminated many more species when they cleared forests and imported animals, such as dogs, cats, the weasel-like stoat that preyed on native animals, and livestock that eliminated their habitats. Apart from the moas, nine birds, one reptile and one mammal are known to have become extinct in New Zealand since 1500. One of the birds, a beautiful forest songbird, the Huia (*Heteralocha acutirostris*), was truly unique: the male and female had different sized and shaped bills. Hunted for its plumes, and with its habitat destroyed, the Huia was last seen in the late 19th century. Others, including a flightless owl; a quail; two wrens, one of which was the only known flightless songbird; a bittern; a thrush; a storm-petrel; a flightless rail; and another songbird became extinct. A gecko and a native bat also disappeared (see Appendix for a chronological list of these species).

Although the Maoris cut and burned portions of the Kauri forests, not until the Europeans arrived in the 18th century did clearcut logging begin. Captain James Cook, the first European to visit New Zealand, noted some very tall trees that were probably Kauris while reconnoitering for lumber on his visit to New Zealand on November 21, 1769: "I judged that there was 356 solid feet of timber in this tree clear of branches." Millions of these great trees were felled for lumber or to clear land, leaving only fragments of the original forests. On the Coromandel Peninsula on North Island, isolated patches of mature Kauri forest are protected in several sanctuaries where old tramways, constructed to remove the logs, still scar the landscape (Molloy 1994).

Overall, approximately 75 percent of native forests in New Zealand have been cleared for agriculture and grazing land for 60 million sheep and other livestock. Fortunately, the Government of New Zealand has set aside many large parks and reserves to preserve landscapes, forests, endemic plants and animals. Thirty percent of the islands are protected, one of the highest rates of preservation in the world. In the majority of western Europe, for example, less than 5 percent of the land is protected, and villages and residences are allowed in many national parks. Not all New Zealand's ancient forests are safe from logging, however. A controlling interest in one of the last sizeable expanses of forest, 193,000 acres on the northern end of South Island owned by Fletcher Challenge Ltd., a logging company, was sold in 1997 to the US lumber company, Weyerhauser.

Many native animals of New Zealand's forests have been pushed to the edge of extinction by a combination of loss of habitat and the introduction of exotic species. Even the weta insects are in decline. Nine weta species are listed on the *1996 IUCN Red List Animals* (Baillie and Groombridge 1996). All four species of kiwis in New Zealand are rapidly approaching extinction, listed as Vulnerable or Endangered by *Threatened Birds of the World* (BI 2000). Authorities now recognize four, rather than three kinds of kiwi, and one, the Brown Kiwi (*Apteryx mantelli*), is endangered, its population having declined 90 percent since 1900 (BI 2000). Among the most ancient of bird species and possessing many unique physical and behavioral characteristics, their loss would represent as important a biological tragedy as the extinction of the moas. They have been placed in their own family, Apterygidae, an indication of their uniqueness. These flightless birds, which weigh from about 2 to 10 pounds, have small, stunted wings with claws on the end that are hidden beneath a cloak of shaggy, brown, hair-like plumage, giving them a mammalian appearance. Their long, pointed, ivory-colored bills are used to probe the leaf litter on the forest floor for earthworms and other invertebrates at night, and they can be heard snuffling as they forage. They have short, strong legs, and long, sharp claws on their toes, used for digging and fighting (Heather and Robertson 1997). Their food supply is ample: 200 species of earthworms live in New Zealand, with the largest species measuring an amazing 40 inches in length and 4 inches in diameter (Molloy 1994).

At the end of the kiwis' bills are nasal openings for their highly developed sense of smell, which aid them in detecting their prey. An acute sense of smell is a highly unusual trait in a bird. Kiwis also have sharp hearing but poor eyesight. Such characteristics are more common in mammals than birds (Hoyo *et al.,* 1992). Kiwis possess other mammal-like traits, such as two functionally alternating ovaries rather than one in the female (Feduccia 1996). In an interesting evolutionary phenomenon, where land mammals are absent, animals totally unrelated to them often develop mammal-like traits. Kiwis mate for life and live in large burrows. The single egg laid by the female is enormous in proportion to her size, weighing 20 to 25 percent of her weight. It is the largest egg, proportionally, of any bird and four times the size that would be expected for a bird her size (Hoyo *et al.* 1992). By comparison, a human mother weighing 125 pounds would have to bear a 25- to 30-pound baby. The hatching process is long and arduous, taking two to three days from the time the chick begins to break out; because the chick lacks an egg tooth, it must kick its way out of the shell with its feet (Hoyo *et al.* 1992). Many chicks die during this process. When the chick emerges at last with damp feathers, its yolk sack is still connected and nourishes it for several days. A miniature version of its parents, it is able to follow them on their nocturnal feeding trips within a few days (Hoyo *et al.* 1992). (Rare footage of incubation and hatching of a kiwi in the wild can be seen in fiBirds of Paradox.fl See Video section F, Birds.)

Kiwis are totally unable to protect themselves against predators, such as dogs, cats, stoats and introduced Australian Brush-tailed Possums (*Trichosurus vulpecula*), who kill them or prey on their eggs (BI 2000). At least 94 percent of kiwis die before adulthood as a result of this predation (BI 2000). The possums also destroy rainforest vegetation by browsing on canopy leaves, epiphytic and ground plants; they have exterminated a native mistletoe (Molloy 1994). Non-indigenous animals have effectively eliminated kiwis from all but a few remote parts of their original ranges. At least one reserve, the 290-square-mile Coromandel Forest Park, has erected a fence within the Kauri forest to keep out possums, protecting kiwis and other native birds (Molloy 1994). Elsewhere, kiwis are being killed by predators; official government protection since 1908 has not stopped their continued decline. Feral dogs killed 500 Brown Kiwis in a population of 900 in less than two months in the early 1990s (Hoyo *et al.* 1992). Another cause of mortality has been steel-jaw leghold traps and poison set out to capture Brush-tailed Possums, although recently the use of traps has been regulated to prohibit any possible capture of kiwis (Hoyo *et al.* 1992). Dependence on humid rainforest habitat has also been a major factor in their disappearance, as this habitat has been destroyed by logging, fire and agriculture (Hoyo *et al.* 1992). Many kiwis are burned to death in the intentionally set fires that follow logging operations, as their shallow burrows do not protect them from the smoke, heat and flames. Often they are afield when fires are set and die in the fires. Those not killed lose their habitat when the humus and leaf litter essential for their feeding is consumed in the fires.

The Little Spotted Kiwi (*Apteryx ownii*) is the smallest and rarest kiwi, numbering only about 1,100 birds (BI

2000). A population of about 950 birds inhabits the 20-square-kilometer Kapiti Island off the southwest coast of North Island (Collar *et al.* 1994), where it was introduced from the mainland. Another introduced population on Tiritiri Matangi Island, a sanctuary of 543 acres off the northern coast of North Island, has adapted well (Molloy 1994). At one time, this kiwi was found throughout the main islands (Hoyo *et al.* 1992). In the summer of 2000, Little Spotted Kiwis were returned to a reserve on the mainland, a step toward their recovery. The Great Spotted Kiwi (*Apteryx haastii*), the largest species, is confined to forests in extreme northwestern South Island in the southern Alps (Heather and Robertson 1997). Although its habitat here is protected, its numbers are still declining from predation (Collar *et al.* 1994). At present, no Great Spotted Kiwis are living on a predator-free out-island (Heather and Robertson 1997), and only one small population is protected by controlling predators (BI 2000).

Another highly endangered bird, and a species almost as bizarre as the kiwi, is the Kakapo or Owl Parrot (*Strigops habroptilus*). The world's heaviest parrot, it weighs up to 3.5 kilograms and is the only living flightless member of the parrot family. It is also one of the rarest birds in the world. Once native to all but the highest mountain altitudes on North, South and Stewart Islands, Kakapos probably numbered in the tens of thousands (Collar *et al.* 1994, Forshaw 1989). They may have flown to the islands at a very early date, long before the land split into North and South Islands, and gradually lost their ability to fly. These 2-foot-long parrots have dull green plumage, mottled with brown, that blends into the vegetation of their rainforest habitat. Known as the Owl Parrot because of large eye discs and nocturnal habits, the Kakapo has another distinction in being the only member of the parrot family to gather in male groups near a bare area where "lek" displays are performed for females during breeding season. Males call females to the lek with loud, low-frequency, booming sounds emanating from their thoracic air sacs. These calls are audible to humans from as far as 3 miles away (Molloy 1994). They perform these booming calls for six to eight hours a night throughout the three- to five-month breeding season, which takes place only every three to five years under normal conditions (Heather and Robertson 1997). Very placid and slow-moving, they are unable to defend themselves against the rats, cats, stoats and dogs that Europeans brought to the main islands.

The range of the Kakapo began shrinking with the arrival of Maoris and their domestic animals, but in 1800 they were still common in central North Island and parts of South Island where their habitats had not been destroyed (Heather and Robertson 1997). The European Stoat, introduced to the islands in the 1880s, proved an efficient predator of these parrots, eliminating them entirely from North Island and all but remote parts of South Island. In 1970, a survey revealed that only 18 Kakapos remained--all males--in Fiordland, South Island, and these last birds were gone by the early 1990s (Heather and Robertson 1997).

Fortunately, a previously unknown population of 100 birds was discovered in 1977 on Stewart Island, a fairly large island due south of South Island, but these birds were under attack from feral cats (Heather and Robertson 1997). After a decade of decline, all the remaining 61 Kakapos were transferred from Stewart Island by the New Zealand wildlife department to predator-free islets located off North and South Islands (Heather and Robertson 1997). In 1997, a lone female was discovered on Stewart Island and was removed (BI 2000). This rendered the species extinct throughout its original range. Unfortunately, many of the parrots starved to death in their new environments because these islets lacked sufficient food. Their natural diet of fruits, berries, nuts, fern fronds, roots, tubers, moss and fungi was abundant in the temperate rainforests and tussock grasslands of the main islands. A 1983 BBC documentary, fiBirds of Paradoxfl (see Video section), filmed a Kakapo chick being fed by its mother, who walked over steep terrain 3 miles each night to obtain seeds and other food for her offspring. Kakapos can live for as long as 70 years, and this longevity has prevented their extinction, since many years pass without any successful breeding. New Zealand wildlife officials finally provided supplemental feeding, which immediately resulted in the first surviving chicks in a decade in 1991. A population of 62 birds survived in 1999, of which 26 were females and 36 males, including six chicks (WC 2000). Although their numbers are slowly growing, many of the males appear to be sterile, and others have been filmed calling alone, rather than in male groups; some seem to be calling in vain, with no females responding (Hynum 1999). An Internet website has been established to monitor these extraordinary birds: www.kakapo.net.

Many other native songbirds, shorebirds, reptiles and amphibians are threatened in New Zealand, and some survive

only on offshore islets where predators are absent or have been eliminated. New Zealand has had success in eliminating cats and possums from several sizeable islands off the main islands, but on North and South Islands, rats, cats and stoats, as well as European deer and goats, are uncontrolled (Molloy 1994). Some 70 million Brush-tailed Possums live throughout both islands, and they are now endangering forest birds by preying on eggs and chicks (Molloy 1994). Exotic plants have also invaded forests, smothering native plants and choking lakes (Molloy 1994). There is, however, a remarkable awareness in New Zealand of these conservation problems and its extraordinary natural heritage. Moreover, the government agencies dealing with wildlife and the environment, TV New Zealand Natural History (which makes superb wildlife films), and scientist-writers such as Les Molloy (1994) are educating the public about this natural legacy, much of which has endured for hundreds of millions of years. Contributions of funds and expertise from many nations and organizations might aid New Zealanders in their conservation work.

Australia

Australia's temperate rainforests are very similar to those in New Zealand, and fragments persist in portions of eastern and southeastern Australia. Relatives of the Kauri, the Nothofagus beeches, and podocarpus trees are native. An exciting botanical discovery was made in one of these forests in 1994. Named the Wollemia Tree (*Wollemia noblei*) after the national park where it was discovered, it is a member of the Araucaria family and somehow escaped attention until 1994. A species familiar to botanists through fossil records, it was thought to have become extinct 50 million years ago (Wilford 1994). A botanist noticed an unusual tree in Wollemi National Park in New South Wales, southeastern Australia and, when he investigated closely, found its fern-like leaves and other proof that it was indeed a living fossil (Wilford 1994). About 23 of these "living fossils" have been located in the park, the tallest towering 130 feet with a 10-foot girth and the species is being propagated by the Australian government. At a press conference soon after its discovery, Ken Hill, botanist at the Royal Botanic Gardens in Sydney, exhibited a fossil imprint of the Wollemia's fern-like leaves next to the living branches for news media, stating that it was one of the outstanding biological discoveries of the century (Wilford 1994). Pictures of these trees were shown on television news programs around the world, an indication of the new appreciation being accorded such natural wonders. These massive pines have dense, waxy foliage and knobby, dark bark with strange-shaped branches growing from the trunk (Wilford 1994). They were found growing in a secluded area of little more than an acre, deep in the national park, where high humidity and moisture probably protected them from fire and provided ideal habitat (Wilford 1994). Had these priceless trees not survived in a national park, they might have been cut for firewood or commercial logs long ago. Wollemi National Park's protection was considered a great triumph for Australian conservationists. It contains the country's largest area of undisturbed forest--more than 486,400 hectares (1,201,894 acres) (Campbell 1989). The Colo River, the last unpolluted waterway in New South Wales, flows through the park. Other trees in this park include tall eucalyptus, which predominate; Snow Gums; Mallees; and pockets of rainforest in gullies (Campbell 1989).

Four species of Australian Podocarps are listed by the *1997 IUCN Red List Plants*. They range from Queensland's rainforests to temperate rainforests in New South Wales and Tasmania. Such forests, with their tall, evergreen trees and understories of tree ferns, are very rare today as a result of climatic change, a gradual drying of the continent and logging. Eucalyptus trees, which can withstand a dryer climate, gradually increased in range in Australia's temperate rainforests since they appeared in the Oligocene Epoch 35 million years ago (Vandenbeld 1988). They first colonized forest edges and flourished in open woodlands, then grew into entire forests growing from Queensland south to Tasmania, having radiated into 500 species (Vandenbeld 1988).

From New South Wales south to Tasmania, Nothofagus beech forests have been edged out by eucalyptus but remain in a few areas, a glimpse of the past. Mosses, ragworts, rotting logs, ferns and tree ferns carpet the forest floor, similar to those growing farther east in southern New Zealand (Vandenbeld 1988). European colonists logged these forests to clear the land for farms and grazing. The ancient eucalyptus, with their massive trunks, dwarfed the teams of oxen that dragged out the logs. This primeval forest is now almost gone. A 19th century artist, Isaac Whitehead,

depicted a magnificent old-growth forest being logged in a dramatic painting showing trees that must have had circumferences of well over 50 feet. If not for the huge stumps that remain, one might have doubted that they actually existed (Vandenbeld 1988).

Forty percent of the country's forests have been cleared, including 75 percent of the rainforests in northern Queensland and 90 percent of both the dry mallee of the south and the eastern temperate woodlands (Parfit 2000). Logging had a devastating effect on the continent's woodland mammals who depended on the forests for survival. Of 144 marsupials inhabiting Australia 200 years ago, 21 are extinct, and a total of 88 Australian marsupials are listed in the *2000 IUCN Red List Species*. Many of these were forest species. Australia has had more mammals become extinct over the past few centuries than any other country in the world. The majority of forests in Australia did not revert to second-growth but became grazing land, plantations, agricultural fields, or tree farms of non-native pines for pulpwood (Vandenbeld 1988).

The eucalyptus forests that came to dominate many of Australia's woodlands are interspersed with savannah in the dryer north. In the south, they grow in dense, moist woodlands, with tree ferns and mosses as ground cover. Among the most characteristic trees of Australia, almost all the great old specimens are gone. Few Australians have ever seen a gigantic, 400-year-old eucalyptus tree, so massive that it takes 15 people to embrace its girth, but such trees were once common (Sharp 1995). It takes 200 to 300 years for a eucalyptus to form nesting holes that provide homes for possums, gliders, bats, snakes, birds, parrots and other creatures that were once prolific in Australia (Sharp 1995). The tallest trees in Australia, many eucalyptus stand more than 300 feet high (Attenborough 1995). In 1880, just before cutting it down, a surveyor measured a eucalyptus that stood 375 feet tall; another inspector around the same time told of a fallen trunk that was 435 feet long (Attenborough 1995). Had this been confirmed, it would have been the world record for the tallest tree ever measured (Attenborough 1995). Their straight, unlimbed trunks rise to great heights before branching. Settlers cut them for building materials and railroad ties, clearing vast areas and threatening many species. An astounding 175 species of the genus *Eucalyptus* are listed on the *1997 IUCN Red List Plants*.

In central Queensland, 5 billion eucalyptus trees were cut to create permanent grazing land for up to 2 million cattle. Up to half of the trees in 100 million hectares in this Australian state have been cut (Arnold 1994). The last forests of Queensland are being cleared for livestock and agriculture at one of the highest rates of deforestation in the world, estimated at 840,000 acres a year (Parfit 2000).

Koalas (*Phascolarctus cinereus*), native to eastern Australia's eucalyptus forests, are entirely dependent on the leaves of these trees for their food. Most animals avoid eucalyptus because the leaves contain toxic oils, but Koalas have the ability to detoxify these oils, which also gives them a natural insect repellant (Berra 1998). They eat about 36 species of eucalyptus and obtain most of their moisture from dew and the leaves (Berra 1998). Forest clearing has had a disastrous effect on their populations. The last large population of Koalas in southeast Queensland was decimated by construction of an expressway, over vehement opposition from citizen groups (Arnold 1994). Likewise, in the state of Victoria in the southeast, Koalas have been reduced to a few remnant colonies as a result of hunting, development, tree cutting, highways, fires, droughts and predation by dogs and foxes. At least 4,000 Koalas are reported killed each year, and about 2,500 of these die after being struck by cars near urban areas (Berra 1998). They have also been victims of a variety of illnesses, including *Chlamydia*, which causes reproductive failure, pneumonia, blindness and other ailments (Berra 1998). They have declined so dramatically that in 2000 the species was listed as Threatened on the US Endangered Species Act.

Outside of protected areas, the last old-growth forests in New South Wales are being cut. The government accorded a giant multinational corporation, Boral, a contract to cut 500,000 tons of woodchips in the mid-1990s. (Arnold 1994). This logging will remove virtually every native forest not protected in national parks in northeast New South Wales, according to Sue Arnold, Coordinator of Australians for Animals (Arnold 1994).

Victoria still retains some old-growth forest, home to a host of rare animals. Old eucalyptus tower over tree ferns, sassafras, mountain pepper and mosses. In 1999 and 2000, loggers began cutting one of the last of these forests

known as the Goolengook Forest (*EarthFirst! Journal* 2000). Aborigines have been able to stop logging in some traditional areas, including East Gippsland, Victoria, but the delicate and endangered native marsupials inhabiting most of these forests may not survive for long.

A strange mammal of Victoria's eucalyptus forests is Leadbeater's Possum (*Gymnobelideus leadbeateri*). Native to the Central Highlands, it lives in colonies in tall, old-growth eucalyptus trees (Strahan 1995). Thought extinct, this marsupial was rediscovered in 1961. With a tail almost twice the size of its body, huge black eyes and a stripe down its back, this possum looks like a cross between a squirrel and a skunk. Each night, it emerges from tree hollows to climb tall trees in search of insects. Forest clearing has destroyed much of its mountain forests (Nowak 1999). Only about 5,000 or fewer Leadbeater's Possums survive, and the species continues to decline as logging clears its habitat (Kennedy 1992). Its dependence on large trees, especially those 300 or more years old which have large tree holes for their nests, has made it very rare (Strahan 1995). Specializing in finding crickets, beetles, spiders and other arthropods beneath the shedding bark of eucalyptus and other trees, it may require, for an as yet unknown reason, a particular species of tree cricket which shelters under the bark of a certain type of eucalyptus (Strahan 1995). This possum also eats gum and tree sap. Less than 3 percent of its total range of 4,000 square kilometers is protected in nature reserves, and 75 percent is located in timber-production forests where tall, old trees are likely to be cut (Strahan 1995).

Tropical Forests

Tropical forests have, for the most part, evolved in stable environments over a period of millions of years, untouched by the recent Ice Ages. The oldest forests on Earth may be in Borneo where the same species of towering trees have been growing for 250 million years. Climates in tropical forests tend to be uniformly warm year-round, with half the year rainy, and the other half dryer but not without rain. Tropical trees generate enormous amounts of moisture. In some parts of the world, the climate has changed over the ages, resulting in islands of forests surrounded by grassland or other habitats. Many scientists theorize that some forests, including the Amazon and African rainforests, went through such climatic changes during the Ice Ages (Collins 1990). Isolation might explain the evolution of a great number of endemic species in these regions, which today are continuous forest. These tropical forests are showcases of evolution.

Tropical forests vary greatly according to altitude, region and species of trees. Each has a different micro-climate, soil type, fauna and flora. They grow in tropical latitudes 30 degrees to the north and south of the Equator (Collins 1990). Among the many types of tropical forests are evergreen wet forests, deciduous dry forests, mountain cloud forests, and mixed lowland rainforests. In general, lowland rainforests are the most biologically diverse, as well as the most endangered. Covering only 7 percent of the Earth's surface, rainforests harbor half its species (Lean and Hinrichsen 1992). Biological research in tropical forests has consistently shown that this great diversity helps stabilize ecosystems and the very life support systems of the planet.

Some tropical forests have been characterized as "hotspots," having exceptionally high diversity of endemic species that are found nowhere else on Earth. All are threatened by deforestation. Two studies by ecologist Norman Myers in 1988 identified 10 highly endangered and biologically diverse tropical forest hotspots in the world; in 1990, he revised that number to 18 (Myers 1988, 1990; McNeely *et al.* 1990, Mittermeier *et al*. 1999a). Myers pointed out that the 10 hotspots named covered only 0.2 percent of the land surface of the world, but contained 27 percent of the plants and also a high percentage of endemic species. *Hotspots*, a book by Russell Mittermeier, President of Conservation International, and other biologists and ecologists, describes 15 tropical forest hotspots throughout the world among a total of 25 hotspots of all types of ecosystems. The high diversity in tropical forests is reflected in the fact that these hotspots covered 61 percent of the land area of all hotspots identified in the study. Many have lost 90 percent or more of their original forests and continue to decline. Originally, these extremely diverse tropical forests

covered 10,635,513 square kilometers; at present, only 1,246,538 square kilometers remain, a loss of 86 percent (Mittermeier *et al.* 1999a). These tropical forest hotspots cover only 0.08 percent of Earth, but harbor 205,789 plant species and 21,903 vertebrate species other than fish (Mittermeier *et. al.* 1999a), a large percentage of the some 248,428 named vascular plants and 23,524 non-fish vertebrates (Wilson 1988). One can only wonder what diversity these areas had prior to their near-destruction. Such astounding facts should result in strong programs to preserve these regions, all of which are being degraded.

The tropical forest hotspots include the Caribbean, Central America, Brazil's Atlantic Rainforest, western Ecuador's Choco region, Andean tropical forests, Indo-Burma, the Philippines, Indonesia and Peninsular Malaysia, the Western Ghats of India, Madagascar, New Caledonia, Polynesia and Micronesia, Guinean Forests of West Africa, and mountains and coastal forests of Tanzania and Kenya (Mittermeier *et al.* 1999).

The richest and most diverse hotspot on Earth is found in the tropical Andes, stretching from western Venezuela to Chile and Argentina (Mittermeier *et al.* 1999a). This area has innumerable isolated valleys, slopes, and peaks in many altitudes, all physical characteristics that contribute to the evolution of a great array of plants and animals. Covering 1,258,000 square kilometers, these forests are interspersed with alpine vegetation and grassland. Between 45,000 and 50,000 kinds of plants are found here, 20,000 of which are found nowhere else (Mittermeier *et al.* 1999a). Birdlife is prolific, with 1,666 species, 41 percent of which are endemic. Andean Cock-of-the-Rocks (*Rupicola peruviana*), threatened Toucan Barbets (*Semnornis ramphastinus*), the giant Andean Condor (*Vultur gryphus*), also a threatened species, and the greatest variety of hummingbirds in the world are resident (Mittermeier *et al.* 1999a). The critically endangered Yellow-tailed Woolly Monkey (*Lagothrix flavicauda*) is native to a few Peruvian cloud forests, and the Spectacled Bear (*Tremarctos ornatus*) and Mountain Tapir (*Tapirus pinchaque*) are other endangered species of the region. Deforestation has destroyed much of the region through slash-and-burn farming and extensive cultivation of opium poppies, which are controlled with herbicides that poison rivers and streams, suspected to cause declines in frogs and toads (Mittermeier *et al.* 1999a). Several national parks have been set aside, including the Madidi and Tambopota National Parks on the Peru-Bolivia border, covering some 2,225,000 hectares.

The Atlantic forest of southeastern Brazil, another hotspot, has been reduced by 92 percent, yet it has been found to contain the greatest diversity of trees in the world: 476 species in a plot of only 2.5 acres, including 104 previously unknown tree species. By contrast, a plot of similar size in a North American temperate forest has only about 20 species of trees. A much larger plot, totaling 129 acres, in an old-growth forest in Malaysia's Lambir Hills National Park has an astounding 1,175 tree species (NGS 1997). This site is surrounded by farms, and nearby forests have been logged to the forest's boundaries. Both sites are tropical forest hotspots.

Africa's tropical forests once stretched in a wide band from Sierra Leone east through Zaire to Uganda and Kenya, and south to Angola. Of the original 3,620,000 square kilometers, less than half, or about 1,760,000 square kilometers, remained in the early 1990s (Martin 1991). The worst damage has occurred in West Africa where logging and clearance for plantations and villages have destroyed at least 85 percent of its rainforests (Collins 1990, Mittermeier *et al.* 1999a). Even the now-extensive forests of the Democratic Republic of the Congo and neighboring countries are being logged so rapidly that, outside reserves, they will have disappeared in 50 years, according to a 1997 study. A primate anthropologist, John F. Oates, researched the destruction of West African forests and the role played by international loan agencies such as the World Bank and the Ford Foundation. His book, *Myth and Reality in the Rain Forest. How Conservation Strategies Are Failing in West Africa* (Oates 1999), carefully documents the establishment of forest sanctuaries that did not protect forests and their wildlife, but encouraged logging, farming and bushmeat hunting. Almost no forest or sanctuary in West Africa is protected from logging, wildlife killing or capture, or other destruction. The rainforests stretching from Sierra Leone east to western Cameroon and the Gulf of Guinea islands of Equatorial Guinea comprise one of the world's most endangered hotspots for biological diversity (Mittermeier *et al.* 1999a). They covered 1,265,000 square kilometers a few hundred years ago, but have been reduced to only 182,348 square kilometers, or 14.4 percent of the original; of the remaining forests, only about 126,500 square kilometers are pristine forest, a scant 10 percent of the original (Mittermeier *et al*. 1999a). These forests are fragmented and largely unprotected. Some 9,000 species of plants exist in this region, of which 2,250 are

endemic (Mittermeier *et al*. 1999a).

Some of the world's most fascinating and unusual wildlife species can be found here as well, including the world's largest frog, the threatened, 3.3 kilogram Goliath Frog (*Conraua goliath*), which inhabits mountain streams in Cameroon. The Western Chimpanzee (*Pan troglodytes verus*) of these forests is highly endangered by forest clearance and killing for the meat trade. Like the Chimpanzees of Kenya studied by Jane Goodall, they are tool-using, employing stones to crack open hard nuts on logs. They may be a completely different species of chimpanzee (Mittermeier *et al.* 1999a). Forest Elephants (*Loxodonta africana cyclotis*) are vital to forest ecosystems as seed dispersers and to open up forest glades for wildlife, such as the threatened White-breasted Guineafowl (*Agelastes meleagrides*) (Kingdon 1989). They also dig waterholes which provide a lifeline for a host of animals. Unfortunately, they are endangered as a result of deforestation and poaching. These forests also harbor many species of little forest antelope known as duikers, all less than 3 feet tall, which dart about the undergrowth in the Guinean forests. Sixteen of the 17 species are listed in the *2000 IUCN Red List Species*, declining from forest loss and intense hunting. The rarest is Jentink's Duiker (*Cephalophus jentinki*), of which only a few hundred remain. There are no individuals of this species in captivity, and no photo has ever been published of this little antelope (Martin 1991).

In spite of these extraordinary treasures, there are few national parks in the Guinean forests, and almost all remaining forests are being commercially logged. In Sierra Leone, the only protected area is Tiwai Island, a 12-square-kilometer, primate-rich area (Mittermeier *et al.* 1999a). The parks that have been set aside, such as the Tai National Park, an extremely important and biologically rich forest in the Ivory Coast, are under siege from illegal hunters, and farmers whittling away at the forest. Kakum National Park in Ghana has been aided by Conservation International in promoting ecotourism over the past six years; a new canopy walk and aid in tourist promotion helped attract 40,000 tourists in 1997 (Mittermeier *et al.* 1999a). Few of the existing preserves are large enough to preserve the diversity of wildlife and plants of the region. Unless dramatic action is taken, many extinctions will take place in the near future.

In Gabon, to the south of Cameroon, recent progress has been made in protecting a large block of forest in the center of the country. Lope Reserve covers 1,900 square miles of Equatorial jungle coveted by loggers. An agreement signed in July 2000 between logging companies, the government and a variety of environmental organizations permanently prohibited logging in this sizeable area (Revkin 2000a). A compromise included the removal of 400 square miles of the reserve area with valuable Okoume Tree (*Aucoumea klaineana*) in order to add 200 square miles of extremely important habitat for primates, elephants and other wildlife (Revkin 2000a). Since 1957 when only a small percentage of Gabon's forests were open for logging, to the present when almost all the country is logged, wildlife has been driven from many areas by logging noise, roads that open up the forest to hunters and loss of habitat (Revkin 2000a). Dr. Lee J.T. White of the Wildlife Conservation Society has documented this phenomenon and has convinced the government to approve a country-wide forest inventory to identify other areas to protect for a network of national parks (Revkin 2000a).

The Lope Reserve, according to zoologist Jonathan Kingdon, does not include the Bee Forest, home to a very beautiful and rare primate, the Sun-tailed Guenon (*Cercopithecus solatus*), first classified and named in 1984. Dramatically patterned in dark gray with white facial markings and long reddish tails, these monkeys were photographed in the mid-1990s lying dead on tables at a market in Libreville, Gabon, offered for sale as meat (Bohan *et al.* 1996). Known only from this forest, this monkey is threatened by heavy logging in the forest by Isoroy, a French company acquired by Glunz Corporation of Germany (Bohan *et al.* 1996). The species is classified as Vulnerable in the *2000 IUCN Red List Species* (Hilton-Taylor 2000). Isoroy cuts about 140,000 cubic meters of logs per year from a 300,000-hectare (741,300-acre) concession in the Bee Forest, exporting logs to plywood factories in Europe (Bohan *et al.* 1996). The prime wood sought by the loggers is from the Okoume Tree, and a four-year study has found major damage being done to the forest in the process. On average, 8.5 trees were destroyed for every Okoume log harvested, and 49 percent of the forest canopy has been disrupted (Bohan *et al.* 1996).

The Sun-tailed Guenon is one of 26 species of guenons considered "refugia" species of African rainforests. During

the Ice Ages, these forests shrank into islands, where many different primates evolved in isolation in these forest fragments. Each has brightly marked facial and body patterns (Kingdon 1989, 1997). These "masked monkeys," many of which were photographed in the spectacular PBS Nature film of that name, are often highly restricted in their ranges and considered threatened by the IUCN. Kingdon, who has studied these primates for decades, believes that they have brightly colored markings in order to see and identify one another in the dark forest foliage (Kingdon 1989).

A close relative of the Sun-tailed Guenon is the endangered Diana Monkey (*Cercopithecus roloway*), endemic to the Guinean region. This lovely primate's jet black face contrasts with its white chest and legs; its back is russet red and gray, and its long tail is black. Its fur seems to have been painted on, so silky and lustrous is its texture. The majority of Americans know little about this species and other endangered African monkeys. This was dramatically illustrated in the summer of 2000 when New York state authorities ordered the confiscation of a pet Diana Monkey kept by an immigrant family. This animal had been bought in a Long Island pet store in 1995, long after its listing on the US Endangered Species Act and New York's endangered species legislation, yet no one seemed to notice when it was offered for sale illegally. The new owners immediately had a veterinarian spay and remove the canine teeth from this female monkey, named her "Cookie" and dressed her in tutus as a family pet. They said they had no idea that she was an endangered species and refused to give her to the state, which planned to place her in the Detroit Zoo with a male of the species. She can never be part of a breeding program, however, and is a genetic loss to the species. Had the plight of these beautiful primates been better recognized and the species better known, this unfortunate incident would never have happened.

Another "masked monkey" native to Ghana and the Ivory Coast has recently been declared extinct, the first primate extinction in several centuries (Revkin 2000b). Known as Miss Waldron's Red Colobus (*Procolobus badius waldroni*), this monkey had colorful, reddish-brown legs and head, and charcoal body. Last seen in the 1970s, deforestation and hunting caused its extinction; thorough searches over seven years within its habitat proved fruitless (Revkin 2000b). Had it been protected in a forest reserve, this colorful monkey would have avoided extinction (Revkin 2000b). This extinction is likely to be followed in the near future by those of many other critically endangered primates as a result of logging and hunting.

The deforestation of Central and West Africa also presents dangers for people. Many scientists warned that an inevitable consequence of opening up Africa's tropical rainforest through logging was the eruption of ebola virus and other diseases carried by native mammals. Such warnings went unheeded, and several outbreaks of the highly contagious and nearly always fatal ebola virus have occurred. Meat hunting of Chimpanzees in Gabon was a source of this virus, which has killed hundreds of people (French 1996).

The number of threatened vertebrates native to tropical forests of all types has grown astronomically in the past 20 years, concurrent with their widespread destruction. Indonesia, Brazil, Peru, Ecuador, India, Madagascar and Mexico are among the countries with the greatest number of endangered species, enormous diversity, and significant losses of tropical forest cover.

Among the hardest hit of tropical mammals are the primates. Ninety percent of all species inhabit tropical forests, and recent surveys have found that 204 species, or one-third of the world's 650 taxa (taxonomic listing including subspecies), are in high degrees of threat; 103 are critically endangered or endangered (Mittermeier *et al.* 1999b). In Southeast Asia, 90 percent of primates are either threatened or near-threatened, an amazingly high rate of endangerment. Primates are in rapid decline as a result of forest loss, killing for the pet trade, hunting for meat, and capture for zoos, the pet trade and research (Mittermeier *et al.* 1999b). The combination of all these factors has pushed some species so close to extinction that some primate species and subspecies have total world populations of fewer than 100 animals (Mittermeier *et al.* 1999).

Focus on Indonesia

Indonesia has the greatest biological diversity in Asia. A vast mosaic of 13,667 islands, Indonesia links two biogeographic regions known as the Sunda subregion, an area stretching from southern Burma and Thailand south to northern Indonesia and Borneo, with Oceania to the south and east. The political boundaries of Indonesia have little to do with ecosystems or ethnic cultures. The giant island of Borneo, for example, has been divided among several Asian countries. Indonesia claims the southern two•thirds, known as Kalimantan, while Malaysia rules two states in the north and west, Sabah and Sarawak, and the small independent country of Brunei lies on the northwestern coast. Likewise, New Guinea, whose Melanesian tribes have inhabited the island for thousands of years, has been divided between Indonesia, which rules with a strong military presence in the western half, Irian Jaya, and Papua New Guinea in the east, an independent nation. Politically, Indonesia has been in turmoil for decades, with a series of presidents who have grown rich on foreign aid and siphoning off profits from exploitation of timber, oil and minerals.

Focus on Indonesia: Page 1

The world's greatest variety of palm species grows in Indonesia along with 10,000 kinds of trees and 25,000 species of flowering plants (Collins *et al.* 1991). About 40 percent of its plants exist nowhere else, and its forests have a diversity of plants equaled only in Amazonia (Collins *et al.* 1991). One high-altitude forest on Borneo, Mount Kinabalu, has 70 species of oaks, and more than 100 grow on the island, along with 30 kinds of squirrels who feed on their acorns. Such trees are usually considered temperate forest species, but in these forests, which vary greatly in altitude and habitat type, an incredible variety grows. Two thousand species of orchids grow on Borneo (Mittermeier *et al.* 1999a). At high altitudes on Mount Kinabalu, the soggy ground is 90 percent covered in orchids, some with flowers as tiny as grains of rice (Lanting 2000).

Forests cover 85 percent of New Guinea (O'Neill 1996), the majority of which are humid, with very rich diversity in the lowlands. Above 750 meters, oaks and Araucaria trees related to those in South America's Atlantic Forest grow. Even higher, above 2,000 meters, tangles of bamboo and *Nothofagus* beech trees grow in great stands (Beehler *et al.* 1986). New Guinea's mountains rise above 4,200 meters, where alpine shrubbery and boggy grassland dominate. Mangrove forest fringes most coastal areas (Beehler *et al*. 1986).

Until the beginning of the 20th century, forests of many types covered most of Indonesia. The isolation of many of the islands from one another resulted in a radiation of evolution in all types of plants and animals. Many species of animals that had become extinct or rare on mainland Asia still thrived in Indonesia--rhinoceros, Asian Elephants,

Tigers and Orangutans, for example. Other mammals, such as the extraordinary, long-nosed Proboscis Monkey (*Nasalis larvatus*), evolved among the mangrove swamps of Borneo. An unparalleled beauty and wealth of birds had evolved. Among these were birds-of-paradise, parrots, lories and cockatoos, colorful songbirds and hornbills. As the 21st century dawns, however, this diversity is in ruins, with many plants and animals close to extinction. The small original populations of many of the endemic species made them highly vulnerable to loss of habitat as the ancient trees were felled, and population growth consumed millions of acres for agriculture.

Of more than 1,500 species of birds native to the islands of Indonesia, or 17 percent of the world's avifauna, 430 are endemic to the country (Collins 1990). Indonesia has twice the number of breeding birds as North America in only one-fifth the land area. Many of these birds live on only one or two small islands. About 164 species are endemic to the Sunda subregion alone. The great loss of forest and other types of habitats in Indonesia is perhaps the most important cause threatening 319 species of native birds, of which 114 are extremely threatened (BI 2000). This is the largest number of threatened birds of any country in the world. Further field research may uncover even more species to add to this list, especially in view of the accelerating deforestation in Kalimantan**,** Sumatra and New Guinea.

Two hundred and one of Indonesia's 436 species of mammals--almost half-- are endemic, an amazingly high rate of endemism (Baillie and Groombridge 1996). Not surprisingly, Indonesia also leads the world in the number of threatened mammals--135 species, or 31 percent of all of its native mammals (Hilton-Taylor 2000). One thousand species of reptiles and amphibians live in Indonesia, 10 percent of the world's 10,484 herpetofauna (Collins 1990). Twenty-eight species of reptiles are considered threatened by the *2000 IUCN Red List Species*, along with at least 59 species of freshwater fish. Research on endangered amphibians, fish and invertebrates in tropical countries lags far behind that in temperate areas, and the endangered list of the latter species is likely to grow when further research is done.

Focus on Indonesia: Page 2

New Guinea has some of the largest expanses of ancient species of trees in the world, most of which grow in cool climates in highlands and mountains. One species of *Agathis* kauri from the highlands of Papua New Guinea is considered rare by the *1997 IUCN Red List Plants*, as are two more *Agathis* species in the Solomon Islands and Vanuatu to the southeast of New Guinea, also bits of Gondwana. The kauri pines (*Agathis macrophylla*) occur on both the latter island groups but have been logged over. Their close relatives on the island of Borneo are in steep decline from logging and land clearance. In New Guinea, logging and clearance for settlements or agriculture, and even native tribes, are destroying these giant trees. Known as "timber trees" in the IUCN-sponsored *Conservation Atlas of Tropical Forests. Asia and the Pacific* (Collins *et al.* 1991), the *Araucaria* pines, relatives of the Monkey Puzzle Tree, grow in groves in parts of New Guinea's highlands, and some tribes venerate them.

Zoologist Tim Flannery (1998) walked among these *Araucaria* trees near the highland village of Telefolip and reflected: "Around the edge of the grove they were saplings but, further in, the pines were soaring giants, mist swirling through their crowns. Their straight, clean boles carried patches of bright green moss, which contrasted with their walnut-colored bark . . . The most striking thing about the grove was the quality of the sound. It seemed as if, in an instant, we had left the noisy, muddy world of drizzle and people and entered a large, open-air cathedral." The grove was considered so sacred by the local tribe that not a single leaf, not even a mosquito, could be disturbed in it (Flannery 1998). They thought that all life had begun in the grove. In the middle of the grove, Flannery saw a rare bird of paradise displaying. The male Splendid Astrapia (*Astrapia splendidissima*) has iridescent colors on the breast and head, and long, dramatic tail feathers that are much desired by the native hunters. These birds are usually shy, but generations of Astrapias had learned that they could display in this sacred Araucaria grove without fear that they would be killed (Flannery 1998). Baptist missionaries worked to end what they called pagan beliefs and offered to

purchase timber cut from this sacred grove; gradually they succeeded in ending the taboos. When Flannery visited the grove in 1992, a great fallen Araucaria lay near the path, its trunk hewn into segments with a chainsaw.

New Guinea's birds-of-paradise have been called the most spectacular birds in the world. They are confined to this island and its satellite islands, and extreme northern Queensland in Australia. Their dazzling plumage, showy courtship displays and haunting songs have inspired awe in all who see them. fiVoices in the Forest,fl a BBC film (see Video section, Birds), featuring these spectacular birds dramatically illustrates their conservation problems. Their feathers have been traditionally used for headdresses and costumes by natives, which has threatened some species. Commercial demand from outside the island for feathers, zoo and aviary birds and dried specimens poses additional threats to them. The entire family of these birds, Paradisaeidae, has been placed on CITES Appendix II to prevent illegal trade. Forest cutting poses an even more serious danger to birds-of-paradise populations. The majority of species inhabit primary rainforests, and many have extremely specialized habitat needs. As clearing continues, and logging roads open up more and more of New Guinea's forests, these birds lose their habitats and are more easily hunted. Four species of birds-of-paradise are listed as Vulnerable, and eight more as Near-threatened by BirdLife International; they comprise 28 percent of the 43 members of this avian family (BI 2000).

Less showy, but no less interesting, are New Guinea's bowerbirds. The constructions of bowerbirds are so elaborate that when explorers first encountered them, they were assumed to be man-made. Each species has variations on the construction, some building bowers with pass-through tunnels, others concentrating on accumulating a vast array of objects collected in piles of the same color to attract females. One very rare bowerbird, searched for in the wild on a dozen occasions, was finally found in the remote Foja Mountains by Dr. Jared M. Diamond of the University of California in 1979. This beautiful bird, the Golden-fronted Bowerbird (*Amblyornis flavifrons*), which may number only about 1,000 birds, is very restricted in range, limited to an area north of the Idenburg River between 1,000 and 2,000 meters (Beehler *et al.* 1986). The male of this species arranges sticks in a pile around a tree fern or sapling, forming a tower up to 3.5 feet high on a circular moss platform with a raised rim. He clears the adjacent area of debris and places separate piles of blue, green and yellow fruits to attract the female. The blue fruit was also a newly discovered species. Making varied, loud calls even while holding a blue fruit in his beak, which contrasts boldly with his brilliant yellow head and back feathers, the Yellow-fronted Bowerbird perches near his elaborate bower performing for the drabber female.

An even more threatened bowerbird, Archbold's Bowerbird (*Archboldia papuensis*), ranges in the central mountain ranges of the island. The male has a long, forked tail and constructs a bower made of a large mat of ferns (Beehler *et al.* 1986). Inhabiting ancient *Nothofagus* beech forests, mixed with podocarps, bamboo and *Pandanus* at high altitudes between 2,300 and 2,900 meters, it has declined as a result of logging operations (BI 2000).

New Guinea's marsupials show great biological diversity, ranging from tree-kangaroos, an arboreal relative of the land kangaroos of Australia, to colorful cuscuses, tiny nocturnal possums and bandicoots. These fascinating mammals remained unknown to scientists until very recently as a result of the extremely rugged terrain, native tribes who were often unfriendly to outsiders, and the almost total lack of roads and other means of access. Many of these mammals are also secretive and nocturnal, hiding in the holes of giant trees covered in vines or inhabiting such restricted ranges that many have only recently been discovered after intensive searches in the wild. In 1865, for example, only 15 mammals had been named from New Guinea, and in 1875 that number had grown to 20 (Flannery 1995). By 1906, 126 mammals had been identified, including 50 marsupials and monotremes, but today it is known that at least 212 indigenous mammals inhabit New Guinea, many of which were discovered within the past decade (Flannery 1995). A surprising number of mammals inhabit a relatively small area and are threatened by forest loss and hunting.

Focus on Indonesia: Page 3

Thirty-eight marsupials and one monotreme (egg-laying mammal such as a platypus) are listed in the *2000 IUCN Red List Species*. One marsupial was previously unknown to scientists until 1994 when Tim Flannery (1998) discovered it in a remote mountainous area of Irian Jaya. This panda-like animal has long, fluffy black fur on its back and head, stripes of white on its belly and muzzle, and a white star on its forehead (see Flannery 1998 for color photo). It resembles no other tree-kangaroo and is also far more terrestrial than other species (Flannery 1998). The Moni tribe call it the "man of the forest," or Dingiso, because when threatened, it raises its arms above its head, exposing its white belly while letting out a whistle, which they consider a sign of recognition (Flannery 1998).

The Dingiso's scientific name, *Dendrolagus mbaiso*, means "forbidden" tree-kangaroo. The Moni believe it to be an ancestor and will not hunt it, but a neighboring tribe, the Dani, has no such taboo and kills the Dingisos for their fur, claws and tail tips. Weighing about 30 pounds and 30 inches tall, this fairly large tree-kangaroo lives in a dense, cloud pine forest up to 10,000 feet in altitude in the Maoke Mountain Range, an area where tree-kangaroos had never been seen. Within the territory of the Moni, this very tame tree-kangaroo is still common and can be easily approached by offering it some leaves; hunters take advantage of this trait by feeding it leaves and slipping a noose over its head (Flannery 1998). This beautiful animal is endangered, and should the protection of the Moni people end for some reason, it will likely become extinct, as it has already disappeared from the territory of the Dani tribe (Flannery 1998).

Focus on Indonesia: Page 4

Fig trees are among the most characteristic trees of Indonesia and other rainforests and are keystone species for wildlife. They are threatened by forest clearance and by loss of their seed dispersers. Some 800 species of fig trees are found in tropical rainforests around the world. On Borneo alone, there are 140 species, 13 of which are endemic (Yates 1992). Among the tallest trees in these forests, they may attain a height of 150 feet. Strangler figs grow on the trunks of other trees, which they gradually kill by encircling them. All fig trees are dependent on wasps less than an inch long for pollination. (See "Borneo's Strangler Fig Trees," by Tim Laman in *National Geographic*, April 1997, which illustrates this pollination process in detail.)

A wide variety of birds and mammals feed on the abundant fig fruits, but few species actually disperse the seeds. Figs contain chemical compounds that have a laxative effect on the wildlife that eat them, a reproductive strategy designed to release seeds over a wide area. Animals as small as ants and as large as wild pigs, gibbons, and deer feed on the fruit (Laman 1997). Figs exist in such variety in unlogged, primary tropical forests that one species is always fruiting, supplying life-giving food to wildlife (Laman 1997). Hornbills may be more important than any other species in dispersing fig seeds because, rather than eating a portion of the fruit only, they eat the entire fruit, which is full of tiny fertile seeds, and then fly long distances, spreading the seeds in defecations. One ornithologist observed fruiting fig trees in Borneo with as many as 50 hornbills of eight species feeding together (Yates 1992).

Focus on Indonesia: Page 5

Hornbills also spread the seeds of other plants. In India, Great Pied Hornbills are vital to the dispersal of nutmeg seeds, since they are the only species with a beak large enough to open the seeds (Youth 1995). Ragupathy Kannan, a biologist studying this species in the Ghats region of southwestern India, discovered that the forestry department was intentionally cutting large fig trees in order to feed domestic Asian Elephants to haul lumber (Youth 1995). Kannan managed to convince them to ban fig tree cutting and, instead, to let Elephants browse freely in the forest (Youth 1995). If such conservation work took place throughout the ranges of hornbills, their future might be brighter.

The decline of hornbills throughout their Asian ranges highlights the loss of seed dispersers, as the forests themselves disappear or become logged over and fragmented. Hornbills are extraordinary birds, with their enormous beaks composed of horn-like material and, often, colorful facial markings. Some have a casque on top of the bill, giving the appearance of a double beak. The Rhinoceros Hornbill (*Buceros rhinoceros*), for example, has a typical downward-curving, white pointed beak, but atop it a bright orange-red casque curls upward at the tip like a rhinoceros horn. This species, native to Malaysia, Sumatra, Borneo and Java, has declined from trade and is listed on Appendix II of CITES. Averaging more than 4 feet long with 3-foot tails, hornbills make dramatic silhouettes as they fly over the forest canopy. Unfortunately, their size attracts hunters who kill them for sport or food, another factor in their rarity outside national parks. Their reproduction is highly unusual--unique, in fact--among birds. Courtship can involve spectacular head•on collisions between males, clashing their casques together. The hornbill pair, which mates for life, selects a nest hole high in a hollow tree, usually one that was created by a large limb falling off and the trunk area becoming rotted.

Since ideal nest sites are rare and found only in trees hundreds of years old, hornbills often use the same nest year after year. The female plasters the inside with droppings that harden, and the male plasters the outside, leaving a slit that effectively imprisons the female in the tree trunk hole for the next three months. She pokes her bill out to receive food from the male, who tips his beak into the female's open one and lets small round figs and other grape-sized fruits roll down. Other adults may help in feeding the chicks and female. Before the chicks are ready to fledge, the female breaks out and leaves the nest; the chick or chicks instinctively reseal themselves for another month, both parents continuing to feed them (Yates 1992). Finally, when ready, the chicks break out of the nest. It is thought that hornbills have evolved this method of reproduction to protect the female and young from tree•climbing predators, such as snakes and lizards. (The courtship behavior, nesting and feeding of the female and chick by the male Red-billed or Celebes Hornbill (*Penelopides exarhatus*) are beautifully photographed in the BBC film, fiCastaways of Sulawesi.fl See Video section.)

Hornbills, so important to fig trees and the host of species that feed on them, are themselves dependent on primary rainforest (Collins 1990). Their nest trees are often intentionally cut to obtain chicks for sale to zoos and in open wildlife markets. When these great trees crash down, they bring with them many adjoining trees, killing small mammals and birds in the process. The dual threats to hornbills of habitat loss and capture have resulted in dramatic declines in their populations. Should all the hornbill species that are threatened become extinct, the extinction of hundreds of other species may result, from the fig trees, whose seeds they spread, to many vertebrates and invertebrates. In 1980, only one species, the east Asian Helmeted Hornbill (*Buceros vigil*), was listed as Indeterminate by the International Council for Bird Preservation (ICBP) (now BirdLife International) as a result of killing to use their large casques for carving (King 1980). But by 1988, that organization listed seven Asian hornbills as threatened with extinction (Collar and Andrew 1988). In 2000, 18 of Asia's 30 species, or 60 percent, of hornbills were listed in *Threatened Birds of the World* (BI 2000). Seven of the 10 Philippine endemic hornbill species are threatened with extinction (BI 2000). The dramatic increase in threat to these keystone rainforest birds is a reflection of the destruction of Asia's rainforests.

Focus on Indonesia: Page 6

Other rare and declining inhabitants of Asia's rainforests play important roles in pollination. Many trees that produce important commercial products need to be pollinated by wild animals. An extremely valuable fruit is the Durian, which is almost unknown outside southeast Asia. In spite of a rank odor emanating from the outer fruit, the yellow core inside the rind is considered a great delicacy, worth more than $90 million a year in markets throughout Indonesia and Malaysia. What is less well known is the dependence of the Durian tree on a particular species of bat to pollinate it. The Cave Fruit Bat (*Eonycteris spelaea*) is the sole pollinator of these valuable trees, pollinating the

flowers while feeding on the nectar of the flowering fruit. Yet this bat is unprotected from the persecution, hunting for food and destruction of its limestone caves that are causing its decline. The number of threatened bat species native to Asia has increased dramatically in recent years, according to the IUCN (Hilton-Taylor 2000). Throughout these rainforests, bats are disappearing, some before their ecological role was known.

Hundreds of tropical plants and trees have evolved for pollination by bats. Most flowers of such trees are found in the canopy, giving easy access to the nectar•feeding and fruit bats, either hanging on long stems, set clear of the surrounding foliage, or clustered on branch tips near twigs where bats can land (Mitchell 1986). These bat flowers open only at night, with odors quite unlike the day•blooming flowers that attract insects and birds; instead, they are musky and sour, which seem to attract the bats (Mitchell 1986). Evolved with shapes that conform to the muzzle of the bat in order to deposit pollen on the bat's face, some flowers have large, trumpet•like openings that almost engulf the bat's head. Others are brush•like with masses of stamens rich in pollen, while still others have numerous small flowers in a ball•like inflorescence producing both nectar and pollen (Mitchell 1986).

The trees that have evolved to be pollinated by bats, some even by a particular species of bat, while providing food for the bats, represent a classic example of mutual dependency. Current logging practices and the killing of many of these bats for food, or destruction of their caves, endanger both trees and bats. Many of Indonesia's threatened bats are fruit bats, and a large number are found only in Indonesia. The Pygmy Fruit Bat (*Aethalops alecto*), for example, is found only on Borneo; the Small•toothed Fruit Bat (*Neopteryx frosti*) is native to Sulawesi; the Javan Tail•less Fruit Bat (*Megaerops kusnotoi*) is restricted to Java; four others are confined to the island of New Guinea. Half of Borneo's 140 mammal species are bats, and more than 50 of these feed primarily on insects (Yates 1992), another major benefit of these poorly understood mammals.

Focus on Indonesia: Page 7

The threats to Indonesia's environment are strongly linked to the growth of its human populations. With the largest number of people on Sumatra, Java and Bali, lowland forests on these islands were cut for cities and farmland during the first half of the 20th century (Collins *et al.* 1991). Beginning in the 1960s, industrial, government-sponsored logging began on many islands for valuable timber. Uncontrolled logging and wildfires have consumed millions of acres for decades, destroying 44 percent of original habitats and nearly all the lowland rainforests in Indonesia (Mittermeier *et al.* 1999a). Java has become nearly denuded, due mainly to the massive growth in human population that totals more than 110 million, almost half the entire population of the United States (Mydans 1996a). The tiny satellite island of Bali has similar crowding problems, and very little forest remains. Between 65 and 80 percent of Sumatra's lowland forests have been cleared to make way for the ever-expanding human population (Collins *et al.* 1991). By June 2000, an estimated 224.8 million people inhabited Indonesia, the equivalent of 82 percent of the US population, living on 741,000 square miles, or 20 percent of the US land area (New York Times 2000).

Among the first casualties of this deforestation and population growth were Tigers, who numbered in the thousands on Sumatra, Java and Bali up until 1900. The populations of each island had been separated for at least 8,000 years (Matthiessen 2000), as each evolved into a separate race. The Javan (*Panthera tigris sondaica*) and Bali Tigers (*Panthera tigris balica*) were far smaller than other Tiger races, with males weighing only about 200 pounds, one•fourth the size of a male Siberian Tiger. Several Javan Tigers were kept in the Berlin Zoo in the early 1900s without any effort to breed them in captivity (see photo in Tilson and Christie 1999). After massive deforestation of these islands and heavy hunting pressure, their populations crashed (Simon and Geroudet 1970). Udjung Kulon, a large national park, was set aside for the Javan Tiger in 1921, but only 20 to 25 of the species survived by 1955, of which 10 were in this park (Simon and Geroudet 1970). By the 1970s, they had disappeared from Udjong Kulon, and only a few were left in Meru Betiri National Park in the far south. In 1980 a careful survey found tracks of at least three Javan Tigers, but there have been no signs since (Jackson 1990). Bali Tigers were once common in the western

portion of the island, but not since 1952 has there been a confirmed report (Simon and Geroudet 1970). Both these races are now considered extinct in the wild, and none survives in zoos (Jackson 1990). These Tigers represented unique genetic strains that are now lost forever. They were the chief predators at the top of their food chain, and their loss impoverished these ecosystems.

The Sumatran Tiger (*Panthera tigris sumatrae*), the largest of the three, is the only surviving Indonesian Tiger. Highly endangered (Jackson 1990), its wild population may total only 500 or fewer animals (Nyhus *et al.* 1999). An intensive conservation program, begun in 1995, involves an international team of biologists who are attempting to determine just how many Tigers are left, whether they have sufficient prey species, how many are being killed by local people and the status of their habitat (Franklin *et al.* 1999). In Way Kambas National Park in the southeast, researchers, using cameras placed on trails, have photographed them. An estimated 36 Tigers inhabit the second-growth forest and degraded grassland habitat in this park of about 1,500 square kilometers. It is completely surrounded by villages, and nearly all its lowland primary rainforest has been cut (Franklin *et al.* 1999). Villagers resent the park's ban on using forest and grassland products, and when Tigers prey on livestock, often because of a lack of natural prey, the villagers put out poison. Sumatra's forest fires and rampant poaching of all large animals in Indonesia may extinguish the last of these Tigers, but the conservation research program intends to involve local villagers in saving the Sumatran Tiger and help address many of their needs in the process (Franklin *et al.* 1999). This race of Tiger is kept in many zoos around the world, unlike the Bali and Java Tigers, and has reproduced. The fragmentation of the forest range of Tigers throughout Asia to India has isolated populations, caused inbreeding, and exposed them to poaching, even in national parks.

The parks created for the Javan and Bali Tigers protect a great diversity of other wildlife and plants. Meru Betiri National Park preserves the last remnants of lowland rainforest in Java (Whitten and Whitten 1992). A population of about 75 to 100 endangered wild cattle, or Banteng (*Bos javanicus*), and Leopards (*Panthera pardus*) are also resident (Whitten and Whitten 1992). Unfortunately, illegal cutting of trees and rattan within the Meru Betiri National Park has been extremely destructive (Whitten and Whitten 1992). Udjung Kulon National Park on the western tip of Java is home to a small population of Javan Rhinoceros (*Rhinoceros sondaicus*), the rarest of all rhinoceros, along with Sambar Deer (*Cervus unicolor*) and Barking Deer (*Muntiacus muntjak*) and Banteng (Whitten and Whitten 1992). Sumatra has several important national parks as well. Mount Leuser National Park's swamp forests protect the last Sumatran Rhinoceros (*Dicerorhinus sumatrensis*), second rarest of the rhinos. This extremely primitive and hairy rhinoceros has been captured for zoos, where most have died and none has been born in captivity. Researchers in the park have tried to prevent further captures of these highly aquatic rhinos in order to preserve the last wild members of the species. This park also has resident Orangutans (*Pongo pygmaeus*), Siamangs (*Hylobates syndactylus*) and endangered Sun Bears (*Helarctos malayanus*). Unfortunately, some of Sumatra's national parks have been overrun with people cutting trees, causing erosion, and replacing forest with agriculture. The Kerinci-Seblat National Park, located along a mountain range in southern Sumatra, encompasses 14,847 square kilometers of forest, but within the park is a virtual city of 273,000 people, growing at a rate of 3.6 percent a year, who denude the hillsides and convert forest to cinnamon, cloves and coffee. They are gradually destroying this entire forest and the watersheds of the island's two most important rivers (Collins *et al.* 1991).

Focus on Indonesia: Page 8

Until about 30 years ago, Borneo had extensive, unspoiled and magnificent forests. The third largest island in the world after Greenland and New Guinea, it covers 215,000 square miles (Smythies 1960). Prior to recent logging and forest fires, it was described as "one enormous forest" by Bertram E. Smythies, author of *The Birds of Borneo* (1960); 75 percent of the island was primary forest, and 10 to 15 percent, secondary forest (Smythies 1960). Mangrove forests grew abundantly along the southern and southeastern coasts, extending far inland, lining major rivers and blending into vast swamp•forests (Yates 1992).

By the late 1970s, an estimated 66 million acres of the country's forests had been classified as denuded (Allen 1980). Forest clearance on Borneo and in Sumatra took a dramatic turn in the early 1980s when landowners and settlers set fire to forests felled for commercial timber, palm oil and tree plantations and homesteads to destroy stumps and brush. This was done in spite of a law banning the setting of fires. The largest forest fire ever recorded on Earth took place in the old-growth forests of Borneo during 1982-83 and lasted for 18 months (Collins *et al.* 1991). More than 9 million acres, or 33,000 square kilometers, were destroyed in east Kalimantan, including 8,000 square kilometers of unlogged dryland primary rainforest and 5,500 square kilometers of peat swamp forest; the rest was selectively logged forest and settlement areas (Collins *et al.* 1991). This was the first time that living rainforest had been seen to burn. Half the new Kutai National Park was destroyed, and another 2.5 million acres burned in Sabah in the northwest of Borneo (Yates 1992). Wildlife was seriously affected, and some burned land was later converted to tree plantations (Collins *et al.* 1991).

During the 1990s, more fires erupted, spreading to adjoining forests. Logging practices involved the removal of the largest trees, leaving leaf litter, small trees and broken branches that dry out (Paul 1998). The logging opened up the canopy, allowing further drying-out of the forest floor, and humidity dropped (Paul 1998). Fires set in clearcuts entered logged rainforest through these logging openings, setting the entire forest afire (Paul 1998). In 1991, another 190 square miles of East Kalimantan burned, and in 1995, massive fires broke out in Kalimantan and Sumtra (Paul 1998). Two years later, an estimated 750,000 to 1.5 million acres of forest burned in Sumatra and Kalimantan (Howe 1997), including a devastating fire in Tanjung Puting National Park, a prime refuge for Orangutans (Paul 1998). So immense were these wildfires that the smoke spread to neighboring countries, causing severe air pollution in cities and towns, and the fires were seen clearly from satellites orbiting the Earth. A Canadian observer from a vessel in the China Sea during these fires wrote to *National Geographic* (December 1998): "Even at 250 kilometers [155 miles] distance from the coast of Kalimantan, the air was thick with smoke. For nearly three weeks we could not see the sun's disk, only smoke-diffused light. The most astonishing and sad event we witnessed happened one night when we were surveying . . . Our ship was engulfed by an ever increasing flock of exhausted birds and bats, all fleeing the fires of Sumatra. Dozens of birds landed all over the deck, where, too fatigued to move, they could easily be approached and handled. In the morning we found several tired bats dangling from overhead steel gratings. I sincerely hope that a new and more benign Indonesian government will prevent such awful, and needless, environmental calamities from happening again" (Christopher Woodworth).

In Borneo and Sumatra alone, 14.8 million acres are estimated to have been destroyed prior to 1998, still charred and black years afterward (Paul 1998). A zoology student and his girlfriend traveled across Kalimantan in the late 1990s, seeing no green except along roads--small farms and banana trees (Paul 1998). In parts of the region, underground fires burn for years, igniting deep beds of peat and coal seams. The Indonesian government's reforestation funds were rerouted, first by President Suharto, then by his successor, President Habibie, to develop industrial oil palm and timber estates (Paul 1998).

After worldwide publicity and protests from other countries about the fires, and condemnation of Indonesia's failure to act against those responsible, in early October 1997, the government revoked the operating permits of 29 companies that had set illegal fires. This had little effect on fire-setting, as more fires broke out in the following year. In 1998, another million acres burned, and in 1999, an area the size of Vermont and New Hampshire burned on Borneo. In the summer of 2000, smoke from Indonesia's illegal forest fires again blanketed nearby Malaysia's capital, Kuala Lumpur, and Singapore (Mydans 2000). After the fires, floods made the forest loss in Kalimantan permanent by washing away soil, leaf litter and nutrients from the fires ashes (Kaplan and Rogers 2000). Exotic Imperata grasses took hold in many areas, poisoning the ground with substances that inhibit the growth of trees, signaling the end of the rainforest (Kaplan and Rogers 2000). Some 80 percent of the forests in the southeast of Borneo are now gone.

During these fires, wildlife, including such critically endangered species as Sumatran Tigers, Orangutans (*Pongo pygmaeus*) and Asian Elephants (*Elaphus maximus*), fled the fires into villages, where many were killed or captured for sale as meat or pets. Stephanie Fried, a scientist with the Environmental Defense Fund in Washington, DC, who

has studied the timber trade in Indonesia, described these fires as the result of "appalling forestry practices and rapacious greed" (Howe 1997).

The fires destroyed most of Borneo's lowland rainforests, where 267 of the world's 600 dipterocarp trees, or trees with "two•winged fruits," dominate; 150 of these exist nowhere else (Whitten and Whitten 1992). This family of trees, Dipterocarpaceae, has species from the Seychelles to New Guinea, but Borneo has by far the most species (Whitten and Whitten 1992). Many reach heights of 250 feet or more and are pollinated by tiny thrip insects. They are extremely important to wildlife, producing fruits, flowers and digestible leaves that are fed on by birds, gibbons and a variety of other animals (Whitten and Whitten 1992). Each year, 2,500 square kilometers of dipterocarp forest are logged in Sarawak, and these old-growth forests are often replaced with tree plantations (Collins *et al.* 1991). Elsewhere in Indonesia, these are the preferred trees to be logged, with their unbranched, wide trunks used in furniture, plywood, resins and camphor (Whitten and Whitten 1992). It was almost inevitable that many of these trees became extinct. The *1997 IUCN Red List Plants* lists a dipterocarp trees native to west Sumatra as Extinct. Another species is extinct on Sumatra but still survives in Peninsular Malaysia, along with 95 other members of the family listed as Threatened or Extinct on the island of Borneo and the rest of Indonesia. Four species of the giant kauri *Agathis* that grow in Borneo's higher altitude forests are also threatened with extinction (Walter and Gillett 1998).

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Orangutans once ranged in mainland southeast Asia as well as Indonesia, but hunting and forest cutting eliminated them from 98 percent of their original territory, leaving populations only on Sumatra and Borneo. These islands were home to tens of thousands of Orangutans at the turn of the century, but since then, these intelligent apes have been pushed into pockets of shrinking rainforest. Orangutans are unable to adjust to second-growth forest and depend on very large ranges within primary rainforest, where they feed on ripe fruit and flowers. Their populations have become scattered from loss of old-growth forest, and even national parks are no longer safe havens for them, as poaching and illegal logging increased in the late 1990s. Orangutan populations decline between 60 percent and 95 percent in selectively logged forests (Newman *et al.* 2000). The logging scares them out of their territories, and they often die of starvation or accidents (Newman *et al*. 2000).

One of their former strongholds was the Tanjung Puting National Park, 741,000 acres on a peninsula on the south coast of Borneo. It was upgraded to national park status in 1982, primarily to protect the Orangutan. This is the largest swamp forest in southeast Asia, with a mosaic of habitats, including primary rainforests. The Environmental Investigation Agency (EIA) of London conducted an in-depth study of illegal logging in this park, publishing a report, *The Final Cut*, in 1999 (Newman *et al.* 1999). Illegal loggers were so blatant that they built a wooden railway to slide out the giant logs. When government officials were notified, they did nothing, as they had apparently been corrupted by bribes from the loggers (Newman *et al*. 1999). In December 1999, biologists in the park found themselves ordered by armed loggers to leave. Similar illegal logging took place in other parks and reserves crucial to the survival of the Orangutan, leaving few areas not seriously degraded (Newman *et al*. 1999). EIA turned over to Indonesian government authorities, including the Governor of the Province, copies of its detailed report on illegal logging, which had uncovered the fact that 70 percent of the timber being processed in Indonesia came from illegal logging (Newman *et al*. 2000).

The World Bank in Jakarta estimated that between 1985 and 1997, Indonesia lost an average of 1.5 million hectares of forest cover every year, with dry tropical forest, an endangered ecosystem, suffering the greatest losses. Sulawesi has been logged out, and this forest type could disappear from Sumatra and Kalimantan in the near future (Newman *et al.* 2000). Logging supplies 2 million cubic meters of timber to its many pulp mills (Mittermeier *et al.* 1999a). The lack of strong government control has allowed corrupt timber barons to emerge and control the rampant

illegal logging that is leaving little of the country untouched (Newman *et al.* 2000). In spite of international publicity about this disastrous state of affairs, and pressure from international donor agencies, the Indonesian Government stated that it would stop the illegal logging, but did not take action. The bribery scandal apparently reaches into high levels within the government (Newman *et al.* 2000). In May 2000, student activists, frustrated by the government complicity in the looting of their national heritage, held four government officials at a port in West Kalimantan after Customs and other officials failed to halt the shipment of an illegal consignment of timber to Singapore. This shipment, with 70 containers of logs, was forced to return to port and its cargo seized (Newman *et al.* 2000). China and the European Union import more than half the timber exported from Indonesia, and to date, no action has taken place by importing countries to confiscate illegal shipments of timber (Newman *et al.* 2000).

The status of Orangutans has gone from endangered to critical. Decades of logging, clearing and forest fires have destroyed the majority of their primary, old-growth forests on Borneo and Sumatra. Thousands were killed during these fires and hundreds that fled burning forests and entered open areas near villages were killed by villagers wielding machetes. Mothers were hacked to death to obtain their babies, who were often wounded in the process. Hundreds of orphaned Orangutans, pitiful, sickly and malnourished, were confiscated during this period and placed in rehabilitation centers. Many died, and the traumatized survivors clung to one another in crowded pens and crates, mass fed by volunteers and workers of these centers. The Leakey Research and Rehabilitation Center for Orangutans in southern Borneo, and two other centers on the island, have cared for hundreds of these orphans. In 1997, the Wanariset Orangutan Reintroduction Project in East Kalimantan received 118 baby Orangutans, and in 1998, 60 more arrived (Paul 1998). In August, 1998, the station held 171 refugee and injured Orangutans, most very young (Kaplan and Rogers 2000). Many mother Orangutans died of starvation, trying to sustain themselves on acacia bark, and their young were so weak they could hold on no longer and fell to the ground. Some mothers were eaten by the starving local people, and others succumbed to disease (Kaplan and Rogers 2000). Even those saved and rehabilitated have a low rate of survival. Fewer than half survive in the wild, according to Martinus de Kam, site manager of the Wanariset Forestry Research Project (Paul 1998).

Birute Galdikas, a renowned primatologist and the world's foremost expert on the species, runs the Leakey center and was almost overwhelmed by the numbers of orphans to care for. Moreover, quite a few Orangutans that had been rehabilitated over the past decade and returned to the rainforest came back to the Leakey center for food as their forests were burned or fruit trees cut. In the early 1990s, Orangutan populations were estimated at more than 22,000, with 9,200 on Sumatra and up to 15,546 on Borneo (Nowak 1999). Few believe that more than 15,000 survived the forest destruction and fires of the late 20th century. Galdikas has stated that the species may be doomed to extinction, left with too little habitat to survive. Two primatologists, Gisela Kaplan and Lesley J. Rogers (2000), who have studied Orangutans for many years, conclude that these fires may have been enough to set the final scene for their extinction in Borneo before too many years. Wild populations are unable to sustain the removal of so many female Orangutans. Their reproduction is among the slowest of any mammal. Males are solitary, and females live with their single young for eight to nine years before having another baby (Kuznik 1997). A loss rate of only five Orangutan females out of 1,000 per year can cause a stable population to decline, according to Mark Leighton, a Harvard ecologist conducting research in Borneo's rainforests (Kaplan and Rogers 2000). This rate was surpassed many times during the 1990s. This picture has been further complicated by the recent genetic analysis of Orangutan DNA, which has revealed that there are two, not one species: the Sumatran has been renamed (*Pongo abelii*) and the Bornean retains the original scientific name, *Pongo pygmaeus*. These two primates have been long separated from one another and developed changes in their genes that warrant separating them as species (Kaplan and Rogers 2000; Hilton-Taylor 2000). There are physical differences as well. The Bornean Orangutan is far larger than the Sumatran, perhaps because it has not had to be agile to flee from Tigers, since the species is absent on Borneo. Both species are listed in the *2000 IUCN Red List Species*, the Sumatran as Critical and the Bornean as Endangered.

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Many islands, including Borneo (Kalimantan), Sulawesi and western New Guinea have had to absorb millions of people relocated from overpopulated Java under a government program. Beginning in 1978 with partial funding from the World Bank, more than 100,000 people per year were relocated to these and other out-islands costing $2 billion by 1992 (Durrell 1992). By 1996, 6 million people had been relocated from Java; Sumatra received the greatest number of people, followed by Kalimantan, Sulawesi and Irian Jaya (Mydans 1996a).

Irian Jaya™s 350,000 square kilometers of forests are still largely intact, but they are rapidly being destroyed by settlers. More than 250,000 people have been sent here, pushing aside the native New Guinea tribes who have witnessed their pristine rainforests cleared, even on steep slopes, for subsistence farming (O'Neill 1996). One tribesman said, "While we believe we are descended from the forest, most Indonesians believe that devils live in the forest and that the forest must be destroyed" (O'Neill 1996). The Indonesian government clearcuts 5 acres of forest for each family and supplies tin shacks, seeds and tools (O'Neill 1996); these shacks are lined up in rows on the remnants of the rainforest that once rang with the calls of birds-of-paradise. Villagers are encouraged to cut trees and are paid $1.30 for each tree by the government (O'Neill 1996). Roads, schools, clinics and other modernizations are planned, and towns of up to 250,000 people are being carved out of the virgin rainforest (Flannery 1998). New Guinea tribespeople are resentful about the forest cutting and have documented many instances of killing and cruel treatment they have received from the Indonesian military (Flannery 1998). They believe that Indonesia has invaded their lands, and they have organized a resistance movement, demanding that the land be returned to them (Flannery 1998).

The relocation program has been a dismal failure, not only for the people who were unable to farm the thin, infertile soil of cleared rainforests, but for the devastated environment and wildlife (Durrell 1992, Flannery 1998). The rainforest is not the only ecosystem that has been destroyed by these settlers. On heath and sandstone ridges on Borneo, stands of Ironwood (*Eusideroxylon zwangeri*) grow. These are very unusual trees for tropical areas (Mittermeier *et al.* 1999a). Many of the Javan immigrants are unhappy with the conditions of their new lives and return home (Mydans 1996a). Irian Jaya is expected to remain a center for relocation, however, since only 4 million people live here, and the giant Freeport mine that has removed entire forests employs large numbers of people who come from abroad to work in the mines, living in air-conditioned, newly built homes. Family planning over the past decade reduced the rate of growth on Java from 2.1 percent to 1.5 percent, or half a million fewer births every year (Durrell 1992), but an influx of as many as 1 million people a year still flood into Java from elsewhere in Indonesia and Southeast Asia (Mydans 1996a). Had Indonesia devoted more of its financial resources to family planning a generation ago, as did Singapore, which now has a stable population with a low birth rate, the highly expensive relocation program would not even have been considered.

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The future of Indonesia's forests and their wildlife may be as bleak as that of other tropical forests in the Philippines, Thailand, West Africa and many parts of Latin America and the Caribbean. The disappearance and endangerment of large, wide-ranging mammals, followed by fragmentation and loss of the fauna and flora of entire regions, is a pattern that is being repeated here. The government has set aside many national parks, but as in other parts of the world, they are rarely given a high priority for protection, and local people are allowed to log and even establish agriculture plantings and villages within them. The native tribes of Papua and Kalimantan may force a change in the attitude of the government toward the forests and even end in a return of the land to the people who have lived there for thousands of years and have a strong bond with the native trees and animals. Violence has broken out between natives and immigrants on both islands, leading to the forced departure of hundreds of people in Kalimantan after many were killed by Dyak tribesmen in 2001. In Papua New Guinea, international rainforest organizations have become allied with native tribes in fighting corporate loggers from Australia, and they have been successful in taking

legal actions that negated corrupt agreements made between their own leaders and the loggers.

The potential for ecotourism in Indonesia is great. The islands are already a major draw for tourists, spending more than $1 billion per year. A powerful movement for democracy is making strides in the country, and with more help from the United States and other democracies of the world, this would become a reality. With a radical change in Indonesia's government, priorities might change to benefit the Indonesian people and their environment instead of making the rich richer at the expense of biodiversity. If that happened, more and more people would learn the value of preserving forests and the country's extraordinary biodiversity for their own benefit as well as that of the entire world. The thin, tropical soils of the country have proven to be best for growing trees, and when this is better appreciated, the tide may turn.

Strong and immediate action is required, however, to prevent biological diversity losses that will dwarf those of any other area on Earth. Stabilizing the human population would be a major step in the right direction. By 2025, it is projected that Indonesia's population will exceed 275 million (Mittermeier *et al.* 1999a). If the government does not stop the disastrous and unsuccessful resettlement program, there will be no wilderness forests left, and the remotest national parks will be invaded for tree and rattan cutting and other destructive uses that will inevitably cause massive animal and plant extinctions.

The participation of international conservation organizations in programs to educate Indonesians to live in harmony with nature and to protect biodiversity is in its early stages. Several of these groups have helped produce field guides, books, posters, pamphlets and textbooks, and the series *Ecology of Indonesia*, in Indonesian (Mittermeier *et al.* 1999a). Protected areas total about 110,000 square kilometers, and the important work of protecting them from encroachment and destruction is being aided by projects such as The Nature Conservancy (TNC) work in a huge, 231,000-hectare national park in southern Sulawesi, Lore Lindu National Park (Mittermeier *et al.* 1999a). In cooperation with the government conservation agency and local groups, TNC is conducting a comprehensive education program that also encourages butterfly farming and ecotourism to stem forest clearing and rattan collection (Mittermeier *et al.* 1999a). Other programs to encourage ecotourism and create sustainable models for local economies have been launched. In some cases, international programs have failed. In the 1980s, the World Bank funded a program to protect a 300,000-hectare national park in northern Sulawesi and help local farmers irrigate rice fields while protecting the watershed. These worked at first, but enforcement lagged and gold miners have entered the park and poisoned rivers with mercury. Forest clearing, hunting and rattan collection have also occurred within the park (Mittermeier *et al.* 1999a). Emergency programs to stop incursions into national parks are needed.

A new and potentially major source of income to benefit wildlife and the environment involves the placement of videocameras connected to the Internet in wilderness areas. These cameras can be solar-powered and placed in tree tops, animal dens, waterfalls or other attractions. Such videocameras, using satellites to beam live pictures or web pages to Internet users around the world for a small fee, are helping to finance the conservation work of national parks in South Africa and Central America. Internet users have increased exponentially in the past decade and are expected to continue to grow in number. Many "surf" the Internet for amusement, while others seek wilderness views or natural history information. If the funds were managed so as to be devoted entirely to protection of the environment and related programs, many millions of dollars could accrue. A conservation organization could publicize the fate of a particular species, group of species or region to raise funds for its protection. Certainly Indonesia has hundreds of appealing animals. Orangutans, Sumatran Tigers, Proboscis Monkeys, gibbons, Babirusa, tiny deer, cockatoos and parrots (some as small as sparrows), birds-of-paradise, bower birds and Komodo Dragons are among animals that could appeal to millions of people around the world. Spectacular and magnificent coral reefs, ancient forests, giant flowers, carnivorous plants, mangroves and wild rivers could also be filmed for the Internet. An Internet site could have biodiversity data for students and the general public and lists of projects that need financial aid. Ecotourism opportunities could also be part of this site.

On behalf of American consumers and those in Japan and countries importing plywood and concrete forms from Indonesia, conservationists could approach importers, building companies, stores and builders to propose substitutes.

In many cases, users of these products have little idea where they came from or the effect their purchase has on forests half a world away. The key to saving Indonesia's wild heritage lies in making it more profitable to conserve it than destroy it, and educating these already highly literate people to preserve their own future in the process.

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Forest

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Introduction

In an Ecuadorian rainforest, great towering trees festooned with orchids whir with hummingbirds. Primitive mammals skitter up massive Australian trees of species older than the dinosaurs. The world's tallest trees grow in northern California; at the forest floor beneath them grows an intricate diversity of emerald green mosses and ferns inhabited by tiny creatures. At the southern end of the South American continent, a forest of small gnarled trees buffeted by sea winds shelters herds of short-legged Huemul deer. Kiwis, in their downy cloaks of brown feathers, probe the forest litter among giant tree ferns in New Zealand's dark rainforests, pushing their long, pointed bills into the soil to extract earthworms. Monkeys with elaborate facial patterns, in blues, reds and blacks, chatter in treetops above a plodding West African elephant herd. New Guinea's dazzling birdwing butterflies, measuring 1 foot across, flutter near moss-hung trees where iridescent birds-of-paradise display and utter resounding, eerie calls. Thousands of insects and hundreds of other life forms may inhabit a single tree, whose fruits and flowers feed countless other animals, each the product of eons of evolution and geological history. These irreplaceable forests are in imminent danger of disappearing. The most biologically diverse of these are the untouched, old-growth forests of the world, of which only 20 percent remain, largely unprotected from destruction.

Benefits of Forests

The great beauty and inspirational qualities of forests belie their important biological tasks. By producing vast amounts of oxygen and water vapor, and absorbing carbon dioxide, they help support all life on Earth. A single mature oak tree produces enough oxygen to keep eight people alive for a year. In 1995, an international team of ecologists working in Brazil documented that each hectare (2.47 acres) of undisturbed tropical rainforests absorbs 1 ton of carbon dioxide per year. The world's rainforests are thus absorbing a billion tons of carbon dioxide a year, one-sixth the amount produced by burning fossil fuels such as oil and coal, according to the National Oceanic and Atmospheric Administration (NOAA). Cutting and burning of forests around the world releases carbon dioxide into the air. The high levels of carbon dioxide in the world's atmosphere have caused increases in average global temperatures. The value of tropical forests in trapping carbon dioxide is so significant that four US utility companies have sponsored a pilot program in Belize to protect large areas of forest and plant trees; energy companies will contribute $2.6 million to a 120,000-acre reserve that will absorb 5.2 million tons of carbon dioxide gas over 40 years (Geatz 1996). The Clean Air Act allows such "pollution credits" to compensate for pollution released elsewhere. In 2000, the US government proposed a massive program of tree planting and protection of forests to compensate for the effects of global warming caused by the release of carbon dioxide and other pollutants.

The cooling effect of forests results from leaf transpiration generating moisture that rises to the atmosphere, forming clouds which release water as rain or other precipitation. When forests are cut, the climate dries as rainfall decreases and soils lose moisture. Tree roots absorb about one•half of the rain that falls, releasing the water gradually during the year (Schreiber *et al*. 1989). In countries with wet and dry seasons, water retention by trees makes the

difference between deadly floods that kill thousands of people and sweep away their homes and precious topsoil, and river levels that remain stable, preserving soil and the environment. Forests stabilize the soil, preventing erosion and landslides and allowing streams and rivers to flow clear.

The leaves, bark and wood of trees have been found to contain hundreds of compounds valuable to medicine and industry. Forests produce a wealth of useful species: oils, gums, resins, tannins, waxes, edible oils, dyes, cosmetics, spices, fruits, nuts and life•saving compounds used in medicine. Spices alone are worth more than $1 billion per year (Schreiber *et al*. 1989). Medications derived from wild plants are worth $40 billion annually (Lean and Hinrichsen 1994). Painkillers, birth•control agents and malaria drugs, as well as quinine, digitalis and morphine, are all derived from tropical forest plants. According to one study, more than 40 percent of all prescriptions in the United States still depend on natural plant sources (Swaminathan 1990). Only a small percentage of wild plants have been tested for medicinal value. In some cases, plants that might have disappeared altogether were found to be medical treasures. The Madagascar periwinkle, native to an island which has lost 80 percent of its forests to deforestation, has been the source of two potent compounds that have proven effective in the treatment of Hodgkin's disease and produce a 99 percent remission in patients with acute lymphocytic leukemia (Myers 1983). Global sales of these two drugs now exceed $180 million a year (Wilson 1992). Taxol, a compound from the Pacific Yew found in the last of North America's old-growth forests, has proven effective against ovarian and other cancers.

In the long run, forests left standing are of greater benefit than those cut and destroyed. The dollar value of natural ecological systems, of which forests make up a large part, in performing services for human society has been estimated at as much as $54 trillion, as seen in Chapter 1 ("Earth's Worth" section). Along with their role in flood prevention and climate regulation, forests provide fruits and flowers to be pollinated by wild insects and birds, and clear rivers as habitat for valuable salmon and trout fisheries (Stevens 1997b). The World Resources Institute in Washington, DC, has calculated that the loss of value from deforestation is four times as high as the value of the timber extracted and the depletion of soils, forests and fisheries amounted to an average reduction of 25 to 30 percent in potential economic growth (Stevens 1997b).

The ways in which forests function are only beginning to be understood. Great fig trees are dependent on tiny wasps to complete their reproduction, and fungi in the roots of trees play intrinsic roles in their survival. Pollinators are key to the health of forests, but for many species of trees and plants, only fragmentary information has been acquired about how they are pollinated and the conservation status of these pollinators. Understanding the interrelationships of plants and animals within these ecosystems is key to their preservation, yet forest ecology is in its infancy.

While logic would seem to mandate that such awesome and useful ecosystems be accorded great respect and legal protection, the opposite is true. They are being destroyed so rapidly by logging, dams, climatic changes caused by human activity, and pollution that the last pristine forests may soon be gone. Even minor alterations in their environments have interfered with their healthy functioning.

Cutting forests for financial gain or to resettle people from overpopulated cities provides developing countries with short-term solutions to problems and one-time profits. Neither the extremely important ecological roles that forests play, nor their value as species storehouses, are appreciated by the majority of the world's nations. The recent spate of massive landslides and floods after periods of heavy rains in countries around the world has, in most cases, been traced to logging that left hillsides and entire regions open to erosion. Millions of people have been left homeless around the world in recent years, and thousands have lost their lives to such floods. These floods may be only a prelude to far more serious and long-lasting consequences of forest destruction. Global warming will increase as forests vanish, especially with the cutting of old-growth trees, which have immense canopies for absorbing carbon dioxide and cooling the atmosphere. Higher temperatures have already brought droughts, increased desertification and caused rivers and streams to lose volume and even dry up. The loss of potential disease cures is another byproduct of destroying forests, and the destruction of these beautiful environments, with their multitude of life forms, may result in collapsed ecosystems that cannot be restored.

Forests' Retreat

As recently as 1960, forests covered one•fourth of the Earth's land surface (CEQ 1980). With continued logging and clearance, two decades later, in 1980, only one•fifth remained forested (CEQ 1980). Since then, forests have continued their decline, losing more than 5 million square miles since 1960. During the last quarter-century alone, the world's forests have shrunk the equivalent of one-half the land area of the United States.

This destruction has threatened thousands of animals and plants with extinction. In fact, forests have the greatest number of endangered species of any ecosystem. Of all types of forests, primary, old-growth forests, especially tropical rainforests, harbor the greatest wildlife and plant diversity and the greatest number of endangered species (Collar *et al*. 1994, Collins 1990, Mittermeier *et al.* 1999a). Second-growth and mixed types of forests are also key habitats for many species, and clearing these forests has threatened thousands of plants and animals.

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Forest destruction is often gradual, a whittling away by settlers and farmers who destroy portions of forest to grow crops using fislash-and-burn,fl in which trees are cut, set afire, and the ashes are used as fertilizer for subsistence agriculture. In tropical forests, the thin soil is fertile for only a few years, and farmers move on to clear more forests. When human populations are very small, as in the case of the native peoples of many tropical forests, their effects are not severe or permanent, as the forest grows back. Non-indigenous people, however, often remove forest cover permanently**.** They do not think of the forest as a source of life, providing food and protection, as native peoples do. The entire center of the 1,000-mile-long island of Madagascar, once a verdant paradise with giant trees and teeming with wildlife, is now a moonscape as a result of such misuse of the land. Millions of rural people in developing countries now depend on wood cut in local forests for fuel. This has been another major factor in deforestation because of the growth of human populations spreading into new regions, cutting trees and clearing away vegetation.

In the Caribbean, Europe, eastern North America, North Africa and West Asia, most of the original forest cover was destroyed prior to modern times. These forests will not return once cut, nor will their diversity. The ecology and diversity of the forests that once covered much of Europe and the eastern United States will remain unknown because they were cut prior to any biological studies. We have only descriptions of giant trees and the wildlife that inhabited these forests. In the temperate rainforests of the Pacific Northwest, however, biologists are studying the last 5 percent that survives of these magnificent**,** old-growth forests. Working in the canopies hundreds of feet above the forest floor, they are making new discoveries about these ecosystems. They have learned that lichens colonize only the oldest forests and are key to fixing nitrogen (Moffett 1997), or converting this essential gas into compounds that can

be used in forming life-sustaining amino acids and proteins (Franck and Brownstone 1992). One forestry student who climbed a 2,000-year-old Sequoia found cones growing only on the outer branches, which can remain on the tree for as long as two decades**;** a rich variety of lichens grow**s** on trunks and branches (Moffett 1997). Such discoveries illustrate the importance of preserving these ancient forests.

Only a little more than a century ago, rainforest and temperate old- growth forest covered millions of square miles in West Africa, Central and South America, Southeast Asia, Australia and the western United States. Early settlers, followed by commercial loggers and large-scale livestock and agricultural interests, permanently destroyed these complex ecosystems. In some areas, second-growth forest or shrub has replaced them. Only in Amazonia, Central Africa, Russia and northern Canada do large tracts of virgin forest remain, and these are now being logged by international corporations.

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A major use of timber is newsprint. Every Sunday edition of *The New York Times* consumes 75,000 trees (Bohan *et al*. 1996). Each issue of *Audubon* magazine, published by the National Audubon Society bimonthly, consumes 1,500 trees to make the 150 tons of glossy paper used to print 500,000 copies, according to its own research (Webster 2001). The trees used in the making of this paper were cut after 12 years by a mechanical harvesting machine that periodically clearcuts and replants with only one type of tree, creating an unnatural monoculture (Webster 2001). To remove the cellulose, chlorine is used, which releases .004 pounds of chlorine and chlorine gases into the air (Webster 2001), less than in the past but still an environmental threat. This organization, like many using large amounts of non-recycled paper, claims that the monocultures are teeming with wildlife (Webster 2001) and, by all appearances, does not consider other alternatives for the manufacture of its magazine. Other magazines, such as *National Geographic*, also use unrecycled, glossy paper. By contrast, The Nature Conservancy decided in the 1990s to abandon use of virgin paper for their magazine, even if it meant a less glossy finish, and now prints on recycled paper. Many other conservation organizations have followed suit.

Tropical woods are also used to manufacture paper. With conservation and recycling by consumers in North America, Europe and Japan, no tropical forest trees would need to be cut for paper. The majority of newspaper used in the United States, which is the world™s largest consumer of paper, is thrown into landfills or burned (Bohan *et al.* 1996). Many tree-based products, from shipping crates to plywood and paper, could be made from other materials, both non-wood and re-used wood. Corporations feed a market hungry for inexpensive raw material. The trees are sold for almost nothing by the countries of origin, resulting in high profit margins for logging companies.

Forests' Retreat: Page 3

In the year 1500, tropical forests covered continental and island areas totaling 5.5 million square miles (Collins 1990). Today, only a fraction of this extraordinarily rich ecosystem remains. The estimates of loss vary. Some scientists count only the acreage of untouched pristine rainforest in their estimates, while others include various types of tropical forests, second-growth and disturbed forests. Satellite images, combined with aerial photography and ground surveys, are giving an ever more detailed and accurate picture of the decline of these irreplaceable forests. One reference, *The Last Rainforests*, edited by Mark Collins (1990), calculated that in 1990, only 3.3 million square miles of tropical forest remained in the world. It estimated that about 54,000 square miles were being cleared worldwide every year (Collins 1990). This authority concluded that 50 percent of all tropical forests had been lost since 1900 (Collins 1990). In the disastrous decade of the 1990s, as much as half of the remaining tropical forests were cut or burned. Although estimates of loss vary, there is general agreement that dramatic losses occurred in many

parts of the world during the 20th century.

This destruction is taking place at a catastrophic rate. According to Dr. Edward O. Wilson of Harvard University, an expert in biodiversity and tropical forests, the surviving tropical forests equal the lower 48 US states in area, and a region the size of Florida is disappearing each year. The Nature Conservancy (2000) estimates that 40 million acres of tropical forests disappear every year. Settlers in many tropical forests have traditionally practiced slash-and-burn. The soil is so thin that it becomes sterile after a few years of farming, and the farmers move on, cutting more forest. Such practices whittle away at forests, but when carried out only by small bands of natives, these cut-over acres tend to recover in time. In many areas, however, European settlers have cleared land in this manner and fertilized the soil, maintaining it as agricultural land or depleting it so severely that the forest can never grow back.

Forests' Retreat: Page 4

Cambodia's last expanses of tropical forest are being lost in a pattern typical of many countries. Intensive logging during the past 50 years has reduced forest cover in this country from 70 percent to only 35 percent (Mydans 1996b). In spite of a logging ban instituted in January 1996 and a ban on exporting logs set in place in April 1995, the country's two Prime Ministers signed secret concessions to sell off virtually all of Cambodia's remaining forests (Mydans 1996b). The ancient teak forests are being openly felled, with logs exported to neighboring countries for profits of $10 to $20 million per month and in spite of official pledges to stop this logging (Mydans 1996b). Elephants are used to haul the logs across rough terrain, and many are abused with drugs to keep them working and overloaded, causing serious injuries or death. Some have been maimed or killed by stepping on land mines. Armed guards protect these loggers and sawmill operators; regional forestry officials, who oppose the cutting, are unequipped to confront them (Mydans 1996b). Already, siltation, erosion, flooding, and destruction of agricultural fields have resulted, and Cambodia's King Norodom Sihanouk, who appears helpless to stop this situation, commented, "If this deforestation does not stop, Cambodia will be, alas, a desert country in the 21st century" (Mydans 1996b).

Asian logging companies have now turned to the pristine forests of Belize, the only sizeable forests remaining in Central America. In 1997, the government of Belize sold logging rights to Atlantic Industries, a Malaysian company, for $60 an acre to clearcut in primary, old-growth rainforest**,** principally for mahogany (Hecker 1997). The company logged in areas outside the agreed-upon area and leveled large numbers of Sapodilla trees, the source of chicle that can be tapped sustainably (Hecker 1997). The deforestation of Central America has been most extreme in El Salvador, Nicaragua and Costa Rica (Collins 1990, Harcourt and Sayer 1996). Fires set by settlers and business interests creating plantations for palm oil and tree farms, burned out of control in the late 1990s in Borneo, Sumatra, Bolivia and Brazil, destroying many ancient forests, including some in national parks.

Secret agreements between various government leaders and international logging corporations or with friends and relatives, for logging rights over large sections of forest are commonplace in many countries. Indonesia and Malaysia, for example, encourage destructive clearcuts in which conservation is not a concern, and fast-paced logging is carried out because the agreements may be negated by a change in government officials (Yates 1992). The largest remaining rainforest in West Africa, a 2.5-million-acre swath in Liberia, is being logged by a Hong Kong timber company as a result of a large bribe paid to the brother of Charles Taylor, the newly elected President of the country (Farah 2001). Such bartering away of the world's greatest treasure-houses of biological diversity is a travesty that will adversely affect the Earth's stability and the lives of many generations of people in the future. Lost will be magnificent ecosystems containing plants and animals not even discovered.

Corporate logging has emerged as the major cause of tropical forest destruction, greater even than the losses to settlers and agriculture. This logging is carried on without international controls and with inadequate national controls. This industry grows each year, and the international trade in wood, pulp and paper is now worth about $100

billion per year, making timber the third most valuable natural resource (Bohan *et al*. 1996). Of this total, a large percentage is timber from tropical forests. By the mid-1990s, scientists estimated that some 80 percent of Southeast Asia's--and a similar percentage of West African and Madagascar's--forests had been destroyed. An in-depth study of corporate logging by the Environmental Investigation Agency (EIA) estimated total sales of one of the largest corporations, Mitsubishi, at $5.3 billion in 1995, controlling a total land area of 9 million hectares (22.2 million acres) (Bohan *et al*. 1996). Mitsubishi's plywood mill in the Brazilian Amazon consumes 130,000 cubic meters of logs every year through the intensive and unregulated harvest of virola trees (Bohan *et al*. 1996). About 75 percent of all tropical forest trees is turned into plywood for disposable packing crates, construction and furniture, according to the Rainforest Action Network (RAN) of San Francisco, California (RAN 1993). The United States alone imports several hundred million pallets of tropical hardwood each year and throws them away after a single use (Revkin 1997).

Forests' Retreat: Page 5

The promotion of a commercial approach to old-growth tropical rainforests, even "sustainable yield," is based on fragmentary and inadequate knowledge of these ecosystems. It is not known with certainty that their trees can be harvested without harm. Sustained yield forestry concerns prevention of the extinction of various tree species by controlling harvest and, to a lesser extent, protecting of watershed and soil, but not necessarily ecosystem protection. Maintaining the complex web of plants and animals that form a forest should be the prime consideration in conservation. To this end, protection from harm is the logical approach until these ecosystems are properly understood. Their ecological value will only be measurable as knowledge about their functioning and their role in the world's climate are explored in the future. In economic terms, they have great potential as tourist attractions, and the new videocam Internet business, as described in the Focus on Indonesia section below, will likely far outproduce short-term income from timber or conversion to agriculture.

An indication of the effects of this destruction is the fact that 76 percent of the 1,186 birds in higher categories of threat, or 902 species, are forest•dwellers, according to *Threatened Birds of the World*, a comprehensive report by BirdLife International, which examines bird status for the *Red Lists of Threatened Species* published by the International Union for the Conservation of Nature (IUCN) (BI 2000). All these birds are in danger of extinction. Some, such as the 182 Critical species, are in imminent danger of becoming extinct. Of the 902 forest birds, 93 percent are native to tropical forests; of these, 41 percent are found in lowland forests and 36 percent in montane moist forests, such as cloud forests (BI 2000). Three-fourths of threatened forest birds are dependent on a particular type of forest, and almost half require near-pristine habitat, with little or no disturbance, or habitat degradation (BI 2000). Only 3 percent of threatened forest birds can tolerate habitat modification. Unsustainable selective logging affects 367 forest bird species, while other threats include clearing forests for small farms (24 percent), tree plantations, clearcutting forest, livestock grazing, cutting trees for firewood, mining in forests and human settlements (BI 2000). An additional 727 bird species are classified as Near-threatened or close to qualifying as Threatened.

Likewise, forests are the major habitat for threatened mammals. The IUCN assigned habitat types to 515 (46 percent) of threatened mammals, finding that about 75 percent inhabited tropical rainforest; of these species, 35 percent in lowland and about 22 percent in montane (Hilton-Taylor 2000). (Some mammals may occupy more than one habitat). Tropical dry forest accounts for another 15 percent; tropical degraded forest, 4 percent; and tropical savannah woodland about 5 percent of threatened mammal habitats. By comparison, temperate broadleaf forest is the habitat for some 4 percent; and coniferous forests, 5 percent of threatened mammals (Hilton-Taylor 2000). The vast majority of threatened frogs and toads are also native to tropical forests.

Many species of tropical trees have been driven to extinction by habitat destruction and the exotic wood trade. The majority of Caribbean islands, which were covered in tropical rainforests when Europeans first saw them in the late 15th century, are now barren. A species of mahogany native to the Caribbean (*Swietenia mahogani*) has been so

heavily exploited that no unstunted specimen remains. Elsewhere, once common species of forest plants and animals have been eliminated or endangered. Where habitats were limited on islands such as Hawaii and Mauritius, fragrant sandalwoods and other trees were cleared, and few--if any--specimens remain of the trees that once made up these forests.

Forests' Retreat: Page 6

The Rainforest Action Network has documented that 140,000 mahogany trees are being logged annually, with each tree worth about $1,500 wholesale in the United States, where most are marketed (Line 1996). RAN states that most of the mahogany trees in trade have been illegally logged from parks, conservation areas or other protected lands, causing ecological damage on a large scale.

Mahogany takes 40 years to reach harvestable size, and the majority of this wood that is traded internationally comes from wild harvested trees. Many tropical species have reached commercial extinction, and Honduran Mahogany, which grows to 130 feet with a massive canopy, is the major target of the logging industry in Central America. By having a market for mahogany, especially a lucrative one, loggers seek out these trees, even in protected national parks. Once in commerce, distinguishing legal from illegal becomes impossible.

Trees that are commercially valuable are often the very ones most important to wildlife for food sources or shelter. The largest and oldest trees produce the greatest profits and are the first to be cut. These trees provide nest holes for owls, toucans, hornbills, parrots, tiny monkeys, lorises and galagos, rare lemurs, and countless other wildlife species. Many species of wildlife use tree holes for shelter year-round. Although some birds, such as woodpeckers, can excavate nest holes, the majority of animals who shelter and nest in tree holes depend on natural cavities. These holes form when tree limbs fall off or from rotting within tree trunks. Research on wild macaws has determined that a lack of trees with nest holes plays a major role in limiting their populations. Macaws nest only in large cavities very high, usually 100 feet or more, in tall tropical trees. Only the oldest and largest trees have tree holes for the more sizeable animals, such as hornbills, macaws and families of small primates who den together.

The Harpy Eagle (*Harpia harpyja*), the world's largest eagle, is endangered in its neotropical rainforests. Its range once extended unbroken from southern Mexico through the Amazon but today it is rare or absent throughout the remaining forests. A major factor in its decline is logging of the tall, old trees it requires for nesting. These eagles need a high vantage point overlooking the treetops to spot prey and to prevent predation on their nests. Harpy Eagle chicks have a long period of fledging, and prior to their independence, they must strengthen their leg and wing muscles. Eagle parents always make their massive nests near the top of giant trees with wide branches near the nest where the chicks can exercise by running across the branches, flapping their wings. As the strongest avian predators in these forests, they must be able to kill animals as large as sloths and carry them off in their talons. Loggers spot these giant trees rising over the forest canopy and cut them for the enormous amount of wood they contain. In much of Central America, selective logging and clearcutting have destroyed many of the former haunts of this magnificent bird.

Dead trees still standing are also prime wildlife nests and shelters, but because they are considered fire hazards, they are cut routinely. Hollow limbs and fallen logs are used by many types of animals for shelter or nesting, and these are usually trimmed off by loggers. Rotting tree trunks and cavities in both standing and fallen trees support entire communities of insects and invertebrates, upon which many vertebrates depend for food, and which contribute to the forest's health.

Modern loggers use mechanized tools and machines to clearcut forests. Chainsaws can cut through the massive trunk of a thousand-year-old tree in minutes. For smaller trees, saws mounted on trucks slice their trunks like

matchsticks, and machines lift the trunks onto logging trucks for transport, trimming off side limbs in the process. Every tree in a forest, ancient or young, commercially valuable or cut only to be discarded, is logged. Forests covering 1,000 square kilometers have been completely denuded in a single clearcut. Huge processing trucks sweep through the forests, creating deep ruts in the forest floor. Roads are bulldozed for this logging, opening up forests, causing erosion to soils and flattening fragile plants. Baby birds, squirrels, bats and tiny primates in tree holes are killed as their homes are sent crashing to the ground and dragged along the forest floor.

Forests' Retreat: Page 7

Kitt Chubb, a Canadian wildlife rescuer, recounted the trauma that one family of owls endured as a result of a mechanical logging operation. Tiny Screech Owl (*Otus asia*) chicks, still downy and being fed in their treehole nest by the parents, suddenly found themselves slammed to the ground when the tree was cut. A giant logskidder machine roared through the woods gathering up the cut trees, including the one containing the owl chicks (Chubb 1995). The machine proceeded through the woods, bouncing and violently rocking over rocks and ruts. This cacophony must have terrified the owl chicks. Finally, the driver dumped the trees with a crash onto a pasture (Chubb 1995). Soon after, an employee with a chain saw began to cut up the trunks, and as he cut into a big knothole, he jerked the saw back when he saw three fuzzy grey owl chicks with their eyes closed tight (Chubb 1995). Amazingly, they had not been injured or killed after being knocked and bounced about. The loggers decided to save the little Screech Owls, bringing them to Chubb's wildlife rescue center. She placed them in a wooden box and returned with the box the next day to the spot where their nest tree had stood. The forest where the owls had lived had been obliterated, and not a single tree remained. Finding a hollow beech stump in the clearcut not too far away, she and fellow rescuers placed the box in the stump, covering the top with leafy branches for shade, hoping the parents would return to feed the chicks (Chubb 1995). The next day, Chubb was surprised to find a frog leg in the box with the chicks, left by a parent owl. The chicks were lively and vocalizing, and 10 days later, they were still healthy and ready to be banded (Chubb 1995). Unfortunately, few baby birds and other animals survive logging operations or are lucky enough to be rescued if found alive.

Even animals as large as bears are frequently killed when they den in large tree holes. If their cubs survive, they will die of starvation if not rescued. Numerous cases of logging operations orphaning or causing mothers to abandon bear cubs are documented each year. A National Geographic Society film, fiMother Bear Man,fl shown in 1998 on "National Geographic Explorer," told the story of three bear cubs found after logging operations and their long return to the wild under the care of a kind and experienced wildlife rehabilitator in New England. Turtles, rodents, snakes and ground birds sheltering in burrows can be crushed to death by heavy logging machines. The soil, no longer held in place by root systems, breaks loose when saturated by heavy rains. Severe erosion on hillsides can cause mud slides that swallow up houses and the forest below, leaving a virtual moonscape, devoid of life. On level areas, rain washes soil into streams and rivers, clogging them, which kills fish and other aquatic lifeforms. Beautiful tropical forests with 300 or more species of trees per acre, a typical diversity, and myriad species of birds, mammals, reptiles, amphibians and invertebrates inhabiting them, become denuded patches of bare soil interspersed with stumps and broken limbs after clearcutting.

Even in remote wildernesses, the heavy machines that are now used to harvest and transport trees create such havoc and noise that wildlife flees. Many species of rare primates and birds disappear from logged forests, unable to adapt to any logging activities. A recent study in Gabon found that selective logging operations so traumatized Chimpanzees (*Pan troglodytes*) that their population in one 2,000-square-mile reserve fell by 80 percent after logging, even though only 10 percent of the trees were cut (Stevens 1997a). Dr. Lee White, a biologist with the Wildlife Conservation Society in New York, who was studying these Chimpanzees, made the following observation when loggers were in the forest: "I had whole chimpanzee communities charging to about five meters and screaming at me, and that's very unusual behavior" (Stevens 1997a). They were observed in logging areas in extremely agitated states,

drumming on trees and calling to each other. The tremendous noise and disturbance by large machines apparently caused them to flee into the territory of neighboring Chimpanzees, where they fought to the death (Stevens 1997a). Both the Chimpanzee and Bonobo, or Pygmy Chimpanzee (*Pan paniscus*), are endangered species, and the latter is unlikely to survive much longer in the wild as a result of logging. Its tiny population inhabits a restricted portion of forest in the Democratic Republic of the Congo, the former Zaire. Both are also killed in large numbers for meat markets by loggers and hunters, who use logging roads to enter forests. The traumatized orphaned young are sold as pets and to others who exploit them commercially.

Forests' Retreat: Page 8

Many of the last old-growth forests have been cut for throwaway products such as shipping crates, concrete forms, plywood, chopsticks and newsprint. Virgin rainforests in southeast Asia, Australia, Alaska, Russia and British Columbia are being logged to supply the enormous demand for such products, destroying entire ecosystems in the process. The United States and Japan have played major roles in the logging and trading of lumber at extremely low prices for industrial uses (Yates 1992). When one country's forests are stripped, loggers move on to another. In this way, the great Philippine forests of Pliocene trees and Central American forests were cut in the mid-20th century, followed by the teak forests of Thailand and the hardwoods of Indonesia and West Africa. These areas have lost 80 percent or more of their forest cover, and loggers have now moved on to Central Africa, Burma, Belize and Amazonian South America. Brazil's beautiful rosewood trees have already been logged to near extinction. The World Conservation Monitoring Centre of Cambridge, UK, conducted a study on commercial logging and found that 304 tree species from Asia and Africa were threatened with extinction by trade (Bohan *et al.* 1996). Fifteen species of commercially logged trees are listed by the Convention on International Trade in Endangered Species (CITES) in the most endangered category.

In response to criticism about clearcutting, some logging companies and conservation organizations endorse selective cutting, or cutting only certain species of trees or trees of a certain age. Yet such logging is also destructive. One United Nations (UN) Food and Agriculture Organization (FAO) study found that selective cutting destroyed as much as 70 percent of forest cover when conducted totally irresponsibly and, on average, destroyed 30 to 40 percent of the trees (Bohan *et al*. 1996). Destruction of non-target trees occurs with the construction of logging roads and use of heavy equipment to extract trees; when tree canopies and vines entangle one another, many trees are brought down, although only one may be cut. A study in French Guiana found that an average of 57 trees are killed for every tree extracted by selective logging (Bohan *et al*. 1996). Research on logging in Sarawak, a Malaysian state on Borneo, found that of every 26 old-growth trees cut, 33 others were destroyed or damaged, and canopies were broken, isolating animals who will not cross open spaces (Yates 1992). The thin tropical soil was also compacted and exposed, preventing natural regeneration of the forest (Yates 1992).

Many logging companies claim that by cutting mature trees selectively on 30- to 70-year rotations, they are conserving forests (Collins 1990). By definition, no tree older than 70 years can exist in such a forest. Such logging will end in destruction of the ancient and diverse forests, with trees 1,000 or more years old harboring a wealth of species that can only grow and prosper in old-growth forests. The more diverse a forest, the more stable ecologically, and logging tends to impoverish diversity by selectively removing certain commercially valuable species.

Thousands--and perhaps millions--of species depend on primary, virgin forests and cannot adjust to second-growth or logged forests. How many, and which species they are, however, is only partially known. Even scientists specializing in forest wildlife have not determined all the species that fall into this category, especially in complex tropical forest ecosystems. Unfortunately, this knowledge is often acquired too late, after logging has taken place and endemic species have disappeared. Logging operations are proceeding with such speed, and the scientists chronicling the damage are so few in number, that in terms of threats to plants and wildlife, only the tip of the iceberg is being

documented.

Forests' Retreat: Page 9

Until the 1970s, no one knew what the effects of clearcutting forests would be on various species of rainforest wildlife. The US government's Smithsonian Institution, with ornithologist Dr. Thomas Lovejoy supervising, conducted the first scientific studies of the effects of forest destruction in the Amazon on a wide range of wildlife. Blocks of interior forest of various sizes were inventoried by teams of biologists with mist nets and live animal traps. After each inventory was completed, the blocks were isolated by clearcutting the forests surrounding them. Then, after a period, they were inventoried again to discover the effects of clearcutting on the wildlife in the newly isolated forest patches. This type of research aims to discover how large reserves must be to preserve the diversity of ecosystems.

The results of Lovejoy's research in Amazonian primary forest indicated that small reserves of 2.5 acres or less lose a large percentage of their wildlife, and the larger the reserve, the fewer the number of species that disappear (Lovejoy *et al.* 1984). Certain species are dependent on large areas of primary, old-growth forest and are quick to disappear as soon as forests are disturbed or fragmented. Bird populations tended to decline in most reserve sizes, and species composition changed. In the smallest plot, 39 species of birds dwindled to 18 species after three years, and in the larger plot of 25 acres, 48 species declined to 38 (Lovejoy *et al.* 1984). The understory species were censused, as opposed to the canopy birds which seem less vulnerable to fragmentation of forest. Ecological dependencies caused some extinctions. For example, army ants thrive in large areas but disappear from smaller ones, and birds that feed on these ants, such as antbirds which are diverse and numerous in primary forests, disappeared within a short period from smaller plots (Lovejoy *et al*. 1984).

In another chain reaction, the White-lipped Peccary (*Tayassu albirostris*) proved to be a keystone forest species. It digs small waterholes to wallow in when ponds dry up, providing habitat for other wildlife. Peccaries travel in large groups seeking their diet of fruits, especially palm fruits, and act as seed dispersers. The key to their survival is territory size: a herd of 100 animals requires a territory of 97 square miles (Fragoso and Silvius 1995). They disappear from smaller forests causing the local extinction of frogs, who lay their eggs in these waterholes. In the Amazon study, four species of frogs disappeared from areas where peccaries had insufficient habitat to survive (Lovejoy *et al*. 1984).

Many other mammals are affected by forest fragmentation. Twenty species of mammals occupied a large, undisturbed forest plot, while only five were left in an isolated 25-acre-forest; a mere three mammal species remained in a 2.5-acre-forest (Lovejoy *et al*. 1984).

Theoretically, extinctions also can be caused when species have limited distributions which are destroyed by logging. A number of birds and mammals, including several newly discovered marmoset species in the upper Amazon forests, inhabit extremely restricted ranges of only a few square miles. Some species of primates will refuse to cross a road, such as a logging road, or an open clearing. Should a road be built in the middle of their tiny ranges, they would face extinction. Since tropical forests have not been thoroughly inventoried, the endemic species at risk most probably number in the tens of thousands.

Butterflies that live only in deep, virgin rainforest are so intolerant of fragmented forest that they disappear from areas less than 250 acres and, even there, survive only in the central core area (Laurance and Bierregaard 1997, Lovejoy *et al.* 1984). Forest butterflies, which exist in amazing diversity, are highly sensitive to the disappearance of their host plants, upon which they lay their eggs, and thrive in greatest number when vegetation is highly diverse. Some cannot tolerate the penetration of light into forests, and others require such large territories to feed that they

disappear from small reserves, according to research by Keith Brown and Roger Hutchings (Laurance and Bierregaard 1997).

In small forest blocks, trees on the forest edge become vulnerable to the effects of wind and fire, fall in far greater numbers than those in the center and succumb to fires that spread from neighboring grasslands. Fires consumed large areas of rainforest in the Amazon during the late 1990s as a result of fragmentation. This was the first record of rainforest fires in this region. Storms blow down trees adjacent to the edges of fragmented forests and, over a period, will destroy the inner primary forest (Lovejoy *et al.* 1984).

Research on forest fragmentation is now taking place in Africa, Asia, Australia, the Indian Ocean islands and elsewhere in the world. Numerous scientific papers on the subject were gathered in a book entitled *Tropical Forest Remnants. Ecology, Management, and Conservation of Fragmented Communities* (Laurance and Bierregaard 1997). Many of these studies paint a grim picture of the effects of forest fragmentation on biodiversity.

Bats are important forest pollinators but are extremely vulnerable to extinction. They are rarely protected and often persecuted. The valuable Durian fruit of Asia is one such plant pollinated by a declining species of rainforest bat. Other food plants pollinated by bats include wild bananas, breadfruit, mangoes, guavas, avocados, almonds, cashews and cloves, according to Bat Conservation International, which is dedicated to changing the negative image of bats and preserving wild populations (see Organizations list for address).

Forests' Retreat: Page 10

Throughout the world, biologically diverse natural forests are being replaced with tree farms of fast-growing pine or eucalyptus. In Japan, cedar is planted over millions of acres for harvesting. The goal of these farms is to replace old-growth forests that take hundreds of years to mature with trees that can be harvested in 30 to 50 years. Large amounts of herbicides and pesticides are applied to prevent the growth of "undesirable" plants and to control insects. These tree farms have contaminated water tables, destroyed natural diversity, and eliminated countless life forms crucial to maintaining the ecological balance of the planet. Moreover, many are now failing even in their goal of producing fast-growing, healthy trees because of a lack of understanding of ecological systems and natural forest functioning. Tree farms are frequently swept by disease and, in the case of Japan's cedar plantations, which cover 10 million acres, shallow roots have resulted in trees blown over in windstorms and landslides after heavy rains. A healthy forest has many species of trees. This diversity discourages insect pests, which tend to specialize in individual species, from spreading and sweeping through the forest, killing all the trees. The variety of trees in a natural forest also means that many are deep-rooted or have root mats that anchor the soil from erosion.

An added environmental threat posed by tree farms is the use of genetically engineered seedlings, whose effects on ecosystems are not yet known. By transplanting genes from other species of trees--and even animals-- into these unnatural trees, the possibility that their seeds could spread to the wild and contaminate natural trees and plants is very real.

Major disruptions in pollination occur in fragmented forests. Natural tropical forests, with hundreds or even thousands of species of trees, have evolved complex systems of reproduction. Because other trees of the same species might be miles away, trees send their pollen far and wide. Insect pollinators travel great distances to find trees of the same species. Biologists have found that even in selectively logged forests, trees were not being pollinated naturally because others of their kind were removed or became too distant; some species self-pollinated, causing in-breeding, while others simply died out (Yoon 1995b). These biologists concluded, "Even the forests that appear the healthiest but are being selectively logged or otherwise thinned may be endangered in the long run by an increase in less desirable inbred seed" (Yoon 1995). Inbred stock usually loses vigor and ability to reproduce over the long run. This

is an ominous finding considering that many conservation organizations and international logging companies have endorsed certain "sustainable" logging programs, urging the public to purchase products identified as such. Moreover, many of these ancient trees tower 200 or more feet, with wide buttresses at ground level to anchor them in the thin tropical soil. Such trees may have stood on the forest floor for 1,000 years and are living monuments, treasures to be preserved, not raw material for packing cartons, furniture or paper pulp.

Preserving Forests

A 10-year mapping project by the World Conservation Monitoring Centre ending in 1996 found that only about 6 percent of the world's remaining forests are protected against logging and development. Because of the rate of destruction and the potential loss of biological diversity, this is an extremely critical situation.

Preserving Forests: Page 1

Much of the logging in the world is a result of markets provided in the United States, Japan and Europe for wood and wood products. Because paper pulp is cheap, there is little effort to find substitutes or even to recycle the millions of tons of paper thrown into landfills each year. The use of trees for making paper is government-subsidized, encouraging waste and destruction of forests. Tree farms have failed to meet the enormous demand for paper. Financial incentives to recycle or use other materials should be made by consuming countries. Finding substitutes for lumber and raw material for paper will be crucial in protecting entire forests. The United States imports 800 million pounds of paper from Brazil every year, to the detriment of that country's forests. In spite of computers and Internet communications, total amounts of paper used in the United States have not decreased; 4.3 million tons of paper are used in US offices alone each year, and millions more tons are used in newsprint, magazines and other paper products. Because of a lack of economic incentive, only a small portion of this paper is being recycled into new paper. In fact, studies of landfills have shown that 40 percent of material in these dumps consists of unrecycled newspapers.

Innovative approaches are needed to encourage recycling and to end subsidies and the importation of wood chips and newsprint from forests around the world. Some of the alternatives to paper made from wood are already in use. Thousands of years ago, Egyptians produced paper from papyrus reeds, and rice is still used to make paper in parts of East Asia. Cotton and flax are the raw materials of fine quality paper used for currency and other purposes.

Many other plant species are now seen as substitutes for wood pulp in making paper. In *A Wealth of Wild Species, Storehouse for Human Welfare*, Norman Myers (1983) mentions one of these, a plant called kenaf, that is a distant relative of cotton and okra. This plant has been cultivated for centuries in Asia for making burlap bags. A fast-growing, reed-like plant, kenaf shows great potential in the manufacture of paper. Its straight, slender stem has no side-stems, nor does it produce the kind of resins that must be eliminated when wood pulp is processed for paper. Planted like corn, it is ready for harvesting in four months and produces five times more pulp per acre than a pine tree plantation (Myers 1983). In research conducted by the US Department of Agriculture, kenaf has proven an excellent

substitute for paper in newspapers and even bank notes (Myers 1983). A few kenaf farms have been established without government sponsorship in Texas and other southern states, and already many organizations are printing newsletters using kenaf instead of wood-based paper. Processing kenaf does not involve the serious water pollution caused when cellulose is removed from wood and pulp is bleached with chlorine. Air pollution from wood pulp processing plants has been injurious to human health (Verhovek 2000).

Earth Island Institute of San Francisco, California, has published a report, *Forest Friendly Paper Guide*, giving more information on kenaf and other non-tree substitutes for paper, including a new paper product by Arboken of Canada that is made from wheat straw, recycled corrugated cardboard and calcium carbonate filler. A publication called *Guide to Environmentally Sound Papers*, issued by an organization called Conservatree, lists more than 400 types of "green" paper. Among these are recycled, kenaf-based, hemp, sugarbeet and corn, grass and crop waste paper. (These can be obtained from Earth Island Institute. See the list of organizations in this book for the address.)

Preserving Forests: Page 2

Most homes are constructed of wood. An average of 40 to 50 trees are needed to build a 2,000-square-foot wood-framed house (Bielski 1996). Building with stronger materials, such as steel, concrete, brick and stone, would spare millions of trees. Moreover, these materials are not vulnerable to infestations by termites, which destroy entire foundations and frameworks of buildings made of wood. To control these insects, pest control companies apply large quantities of extremely toxic pesticides that can leach into the soil and water table, killing wildlife, and pose hazards to the occupants of the house. The Institute of Ecolonomics in Ridgeway, Colorado, reports that a new tree-free "wood" has been developed for use as building material. Called BioComp, it contains half recycled plastic and half agricultural residue and, according to the Institute, is twice as strong as Douglas Fir, termite-proof, impervious to water, and can be made fire retardant. BioComp resembles wood and is easily molded, sawed and nailed. Some alternatives to wood are also less expensive. Steel is being used in New England homes for major support beams with a metal roof for less money than the same home would cost made of wood (Hotton 2001).

The Wood Reduction Clearinghouse has been formed in San Francisco to address the failure of considering consumption as a driving force in deforestation (Bielski 1996). A group of leading environmentalists issued a statement in 1995 calling for a 75 percent reduction in wood and paper use by 2025, and strategies for eliminating the need for wood altogether are being explored (Bielski 1996). The use of timber for shipping crates and concrete molds--especially tropical hardwoods--should be phased out and substitutes, such as plastics, phased in that would be more economical because they could be reused. Some stores are already using substitutes for the millions of cardboard cartons used to ship goods.

Preserving Forests: Page 3

At the 1992 "Earth Summit" in Rio de Janeiro, Brazil, convened by the United Nations Conference on Environment and Development, world leaders agreed on the importance of slowing the rate of global forest destruction. Conservationists have pressed for a new, legally binding Global Forest Agreement to conserve and manage the world's forests. In spite of the urgent need for such an international treaty, no agreement has been reached in the intervening years. Numerous meetings and conferences between nations have failed to draft a policy that would curtail the uncontrolled commercial logging that is ravaging forests around the world.

Several organizations, including the Environmental Investigation Agency (EIA), headquartered in London, and the

World Resources Institute (WRI) of Washington, DC, have issued reports that chronicle the damage being done and the need for such a treaty. EIA's report, *Corporate Power, Corruption & The Destruction of the World's Forests, The Case for a New Global Forest Agreement*, argues for the need for international agreements to control commercial logging (Bohan et al. 1996). This report gives detailed information on the companies doing the most environmental damage to the world's forests and the methods used by these corporations to bribe and otherwise corrupt the leaders of poor nations to obtain logging contracts. Other organizations, such as the Rainforest Action Network, agree that international logging corporations must be regulated. This $100-billion-a-year trade operates with generous tax breaks from the countries where companies are based and the granting of logging concessions that often cover millions of acres through special arrangements made behind closed doors with government officials (Bohan *et al.* 1996). Logging concessions almost always ignore or overrule strict legislation already existing in many countries protecting the environment and wildlife, including endangered species (Bohan *et al.* 1996).

At present, cutting of forests is "regulated" only by the timber industry itself through the Tropical Timber Agreement, signed in 1983 by various international lumber companies. This agreement does not protect wildlife and the environment. In spite of renegotiation in the mid-1990s, the agreement still does not address ecological concerns or species preservation. Pressure from multi-national companies, primarily Japanese, to supply this lucrative market have overwhelmed the voices of conservationists throughout the world.

Logging in Central Africa is in the process of destroying the once vast and unspoiled forests. A conference in 1999 was convened by the World Wildlife Fund (WWF) to reach an agreement about the fate of these large tracts of tropical rainforest in Africa, located in Cameroon, Central African Republic, Gabon, the new Democratic Republic of the Congo, Equatorial Guinea and the Congo. In this region, 40,000 square kilometers of forest are being destroyed a year, endangering hundreds of wildlife species and opening up the forest to a devastating trade in bushmeat. Prince Philip, in speaking on behalf of WWF, stated that the organization hoped to protect 10 percent of this vast forest, an area too small to prevent extinctions and great biodiversity loss. The Democratic Republic of the Congo, which is in a state of political chaos, did not attend the conference, and no pact was signed.

Preserving Forests: Page 4

The forests of the Democratic Republic of the Congo are among the wildest and least explored in the world, but this wilderness is being invaded by loggers and meat hunters. Michael Fay, a biologist with the Wildlife Conservation Society in New York, has been on a mission to cross this vast area on foot, accompanied by some natives and correspondents, describing the amazing sights along the way. He is trying to draw attention to this region and the urgency of saving it while most of it is still in pristine condition. He has already succeeded in having a sizeable national park established. His trek is dangerous, with poisonous snakes, leeches, tropical diseases and other threats, but he is a dedicated conservationist and scoffs at the dangers. The National Geographic Society is helping to sponsor his trip and publishes regular articles in their magazine on his progress, and their website gives more information. Several short films have also been made for the National Geographic fiExplorerfl program. His mission is extremely important and has the potential of preserving entire ecosystems of threatened animals and plants.

A growing awareness of the problem, along with creative solutions, give hope that in at least some parts of the world, large tracts of tropical forests and their wildlife will be spared. Two enormous parks were established in Suriname and Bolivia in the 1990s, mainly as a result of the work of Conservation International, a US organization that successfully convinced the governments of these countries that such protection will be far more beneficial for the country than short-term exploitation and forest clearance. Other organizations are working effectively in central Africa, Peru, Brazil, Burma, Laos, Vietnam, and the Philippines to protect these species-rich forests.

New approaches to deriving funds from forests without logging and destroying diversity include regulated

extraction of non-wood products, such as seeds, fruits and plants, for food and medicinal purposes. Ecotourism is one of the most lucrative and growing industries in the world, with revenues in the billions of dollars and rising.

Old-growth forests are being cut not because they provide raw material that cannot be found elsewhere, but because they provide a high profit margin to European, North American and Asian logging companies. Decisions made about the fate of these forests, upon which the survival of so many species depends, are not being made by the people where logging takes place, nor by conservationists. These precious and irreplaceable resources, habitat of the majority of the world's threatened species, are being sold to logging companies for pittances. The United Nations has recently endorsed the concept that forest diversity must be maintained, joining the ranks of many other international organizations. In time, society may learn to preserve these storehouses of evolution with the same zeal that great works of art are protected.

Preserving Forests: Page 5

One project has greatly improved the standard of living for villagers in India, while taking steps toward protecting the forest habitat of the highly endangered Bengal Tiger. Many thousands of residents were forced to move when Ranthambhore National Park was established decades ago, causing much resentment. At first, they were banned from gathering firewood and grazing livestock within the park. This had an extremely positive effect on the forests, which regenerated, and Tigers, deer and other wildlife prospered. Gradually, however, park authorities became more tolerant of the incursions of local people and their livestock into the forests. During the 1980s, large areas became deforested, and poaching endangered Tigers and deer within the park.

To reverse this trend and preserve the habitat of this park's wildlife, a Tiger conservationist and author, Valmik Thapar, established the Ranthambhore Foundation. This Foundation sponsored a nursery which propagated 500,000 tree seedlings, employing villagers to replant the national park. It set up a farm with domestic buffalo which had been bred with milk cows and kept in stalls and enclosures away from the forests. These animals yield far more milk than the emaciated Indian cows overgrazing the forests; fuel for cooking and heating is provided by a bio-gas plant producing methane from the buffalo's dung; a new crafts industry employs women in the village (Ward and Ward 1993). In the first four years of the project, 6,000 school children from local areas were taken into Ranthambhore National Park for education programs (Currey 1996).

A Cable News Network (CNN) reporter, Gary Streiker, visited one of these farms outside Ranthambhore National Park in mid-1997. The villagers were economically better off and appreciated having the bio-gas fuel, which saved them the effort of scouring the landscape for firewood, often a full-day's activity. This allowed them to devote time to crafts and other small businesses. Unfortunately, some of the other villagers around the park were still gathering wood, denuding the park. These age-old customs will be difficult to change. Eco-development and conservation projects in 60 villages surrounding Ranthambhore National Park have been launched. Conservation education on the importance of saving the forests will help to change attitudes and protect the park's wildlife and trees. This will bring tourists and new sources of income.

Preserving Forests: Page 6

Several remarkable successes have proved a positive contrast to the otherwise gloomy trends of forest destruction. In South America, large expanses of undisturbed tropical forest remain, but they are fast disappearing. The Amazon Basin and its forests once covered 2.3 million square miles, comprising three•fourths of the world's tropical forests, but forest clearing has destroyed some 20 percent of the original forests and damaged far more. Amazonian forests

contain 14,000 endemic species of plants (Harcourt and Sayer 1996).

Parque Nacional Madidi, Bolivia's newest national park, covers 4.7 million acres, protecting a variety of threatened habitats and species. Avian diversity for this park is estimated at 1,088 species of birds, or 11 percent of the world's birds, the highest in any protected area in the world; among these are many threatened species and others with small ranges (Remsen and Parker 1995). This park, watered by numerous rivers, borders eastern Peru and includes a variety of threatened environments. Humid lowland forests, grasslands and montane cloud forests are among these. Resident birds include the threatened Yellow-rumped Antwren (*Terenura sharpei*) and various species of tinamous and curassows (Remsen and Parker 1995). The latter birds are among the first species to disappear from areas as a result of hunting and habitat destruction. A proposed hydroelectric dam, which would drown large sections of rich lowland forests., is a major threat to the park. It may have been stopped as a result of publicity by *National Geographic* magazine, which featured a cover story in 1999 on the importance of saving this park. Public opinion and the potential tourist trade may compensate this country for lost revenues from the dam. An even larger park of 8.6 million acres along the border with Paraguay, the Kaa-Iya del Gran Chaco National Park, protects the most sizeable block of endangered dry tropical forest in the world (Seve 1996). These two parks will preserve more than 20,000 square miles, and native tribespeople will play a role in administering them (Seve 1996).

Another positive development is the trend in a growing number of countries to share the profits from national park fees with local people and involve them in the decision-making processes of managing the park and the local wildlife. Madagascar has been successful at this, combining income from park fees with international grants to build schools, libraries and clinics for the local people. Patricia Wright, a primatologist, helped establish Ranomafana National Park to protect endangered lemurs as well as to protect the watershed from floods. In the recent past, deforestation carried out by local villagers had caused landslides that inundated their homes and caused water sources to dry up. They have become convinced of the importance of preserving the forests for their own survival. This new approach of educating local people on the benefits that would accrue to them as a result of conservation, as well as payment from park fees and profits from ecotourism, is the future of forest preservation.

Another trend that will prove important is the involvement of biologists studying wildlife with local people, learning from their observations and sharing the knowledge they uncover. Biologists in Madagascar who rediscovered an owl thought extinct, brought local students to see it and raised money for needed school supplies from birdwatchers who came from around the world to see the bird. This creates a positive impression on the local people and instills natural history curiosity and a realization of the uniqueness of their own wildlife. In the future, this may be expanded by showing them films about the natural world that surrounds them and opening up new worlds with books and publications about the subject. Very few people are aware of the endemic wildlife and plants in the environments in which they live, whether in the United States or the Cameroon. When people learn of the flora and fauna in their neighborhood that exists nowhere else, or is of biological importance, they are far more likely to protect it. Even in the United States, where Natural Heritage Programs chronicle the endemic and declining species of every state, the information has not always been made available to the public in the form of state publications or television or newspaper publicity that could have a major effect on whether forests and other habitats are protected.

A recent campaign to alert the public to the ecological advantages of choosing shade-grown, organic coffee has helped preserve rainforests in many parts of the world. A trend toward planting coffee plants in open fields rather than in the traditional way, as an understory to tall trees, has been devastating to tropical forests, home to both tropical birds and other animals, and to migratory birds from North America who spend the winter in Latin America and the Caribbean. Smithsonian biologists began this campaign in 1990 when they saw bird species decline with the planting of sun-grown coffee plants, and patented the logo "Bird Friendly" coffee. Such coffee is now commonly sold in health food and specialty stores and may become more popular as the public is educated about the problem. With the enormous popularity of coffee, this could make a major difference to birds and other wildlife.

North America™s Forests

The history of the destruction of all but 5 percent of the 850 million acres of old-growth forests in North America has been recounted in Chapter One. Second-growth forests now dominate the East, forests far different in species composition from the original virgin forests. The great chestnuts, elms and beeches are gone, and woodlands are now young, mixed pine and hardwood. Moreover, these forests are fragmented by roads and development. Only a few roadless areas remain. A few remnants of old-growth forests have been located in the East, primarily on steep slopes and areas that loggers found difficult to reach. In southern Maine, for example**,** a biologist recently located a stand of Black Gum trees, some 9 feet in circumference. One stump had 450 rings, and another, larger one was still thriving. It was estimated to be more than 500 years old, dating back to the time of Columbus. Unfortunately**,** this area is in the path of development (BG 2000). The Great Smoky Mountains National Park is a large block of forest totaling 500,000 acres in the southern Appalachians of eastern Tennessee and western North Carolina. This national park harbors some virgin old-growth and a wealth of rare native trees, plants and wildlife, including a great diversity of salamanders that inhabit its damp, mossy forest floors and fast-flowing streams. It sits atop a mountain range that is a meeting place of northern and southern species, an important area to the endangered Appalachian forest ecosystems and a primary migratory stopover and nesting area for threatened wood warblers and songbirds. This area recently has been designated an International Biosphere Preserve, and its diversity is being inventoried by a team of biologists and other earth scientists.

North America™s Forests: Page 1

Migratory songbirds of eastern forests have declined by at least 45 percent in the past 50 years. These dazzling migrants--wood warblers, vireos, tanagers, orioles, grosbeaks and thrushes--suffer from a variety of threats. Deforestation of tropical forests where many of these birds spend the winter has been a major factor. Species requiring mature, undisturbed forest have declined to the greatest degree, some losing up to 90 percent of their populations. Clearcut logging and fragmentation of their breeding forests by housing, malls, roads and other

development have consumed millions of acres, displacing these songbirds. Many birds returning from tropical wintering grounds find their breeding forests destroyed or too small for successful breeding. A small patch of woods large enough for only one male songbird, surrounded by agriculture or development, will be abandoned if the male is unable to hear the songs of neighboring males (Line 1995). Many birds establish territories and maintain them by singing and challenging other males.

Another effect of forest fragmentation has been the proliferation of forest edge species that prey on songbirds and their eggs (Terborgh 1992). The Brown•headed Cowbird (*Molothus ater*), a parasitic species, was once seen only in grasslands. In the past, when huge herds of American Bison roamed the prairies of the Midwest, cowbirds accompanied them, laying their eggs in the nests of grassland birds, who raised them as their own. With the disappearance of the Bison, cowbirds entered the forests bordering agricultural and pasture land, laying their eggs in songbird nests. Some cowbirds now remain close to domestic cattle and fly into the nearest woodland to lay their eggs. Their eggs usually outnumber those of the host species, and the large chicks instinctively nudge the small songbird nestlings out of the nest. Because of the increase in forest openings, the net result of these losses has been a 90 percent decline in the number of songbirds recorded in the 1940s in many eastern forests (Terborgh 1992).

A campaign to declare a large section of the forests in northern New England a reserve began in the mid-1990s. To add urgency to the need for a national park in Maine, New Hampshire and Vermont, a new species of thrush, native only to this region, has been discovered. Once considered a subspecies of the wide-ranging Gray-cheeked Thrush (*Catharus minimus*), Bicknell's Thrush (*Catharus aliciae*) was found to be a totally distinct species in 1995, smaller and with a unique song. A bird of high altitude forests, it has already disappeared from its only nesting area in Massachusetts, Mt. Greylock. The major breeding area for Bicknell's Thrushes is now Vermont, whose forests are under pressure from ski developments and proposed wind turbines. Additional populations of fewer than 3,000 birds inhabit neighboring southern Canada, but the traditional practice there of thinning forests renders these forests unsuitable. Its habitat of spruce-fir forests is dying out from acid rain and global warming (BI 2000). This threatened bird is also losing habitat in its West Indian wintering grounds, especially Hispaniola, where forests are being cleared (BI 2000).

Another member of the thrush family is declining toward extinction. Known for its melodious, fluted song, which many find more intricate and beautiful than the Nightingale's, the Wood Thrush (*Hylocichla mustelina*) has declined precipitously in recent years. Native to undisturbed hardwood and mixed forests in eastern North America, the Wood Thrush winters in Central America, from southern Mexico to southern Panama (Rappole *et al.* 1983). In August, these birds begin their southerly migration, often gathering in groups where the chorus of 50 or more Wood Thrushes may echo like a cantata in the tall trees. One research project studied these birds in one of their tropical wintering areas in the Tuxtla Mountain region of southern Veracruz, Mexico, on the Gulf of Mexico. Studies of this population of birds began in the mid-1970s when the wintering habitat consisted of primary rainforest. (Rappole *et al.* 1989). This forest has declined by 85 percent, a far higher percentage than elsewhere in Central America, leaving mere fragments of the once rich tropical rainforest (Rappole *et al.* 1989). In 1980, the two researchers returned to find that their 12-acre rainforest study plot had been converted to a patchwork of fields and forest fragments; less than 5 acres remained of the original forest (Terborgh 1989). Using radio•tracking and mist netting, researchers discovered that Wood Thrushes do not adapt to forests without tall trees, even as a wintering area, preferring undisturbed rainforest. Year after year the same individual birds returned to the same sites. In rainforest, they tended to survive the winter, while Wood Thrushes forced to winter in neighboring second-growth or disturbed forest had a high mortality rate from predators and other causes (Rappole *et al.* 1989).

Throughout their winter range, the forests that once harbored tens or perhaps hundreds of thousands of Wood Thrushes in Mexico and Central America have been turned to pastureland or tilled for agriculture. Between 50 and 70 percent have been destroyed (Collins 1990). Fewer and fewer Wood Thrushes return to nest in Eastern forests, even when they have not been fragmented or cleared (Terborgh 1989). Their nests have also been vulnerable to parasitism by Brown-headed Cowbirds (Terborgh 1989). In Illinois, for example, where Brown•headed Cowbird populations have skyrocketed in past decades, one study found that 29 of 30 Wood Thrush nests had been parasitized by

Brown-headed Cowbirds, who laid eggs that crowded out those laid by the thrushes; the conclusion of the study: "Wood Thrushes are doing nothing but raising cowbirds" (Terborgh 1989). In the few areas where forests are unbroken and extensive, Wood Thrushes have been successful breeders (Robinson 1996).

Unfortunately, the combined effects of habitat destruction in both its breeding and wintering grounds, and parasitism of its nests by cowbirds, may result in the extinction of the Wood Thrush. A recent study in several Midwestern states found that birds from large stretches of forest that are holding their own may be having young that disperse to neighboring forest fragments, only to be crowded out by cowbirds (Robinson 1996). The melodic Wood Thrushes are disappearing throughout their range, along with many other beautiful songbirds.*

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*See Video section. fiOn a Wing and a Song,fl a Canadian Broadcasting Co. film produced in 1994 for The Nature of Things series, explores the decline in songbirds. Another excellent film on the same subject with a similar title, fiOn a Wing and a Prayer,fl produced in 1995 by Kurtis Productions and WTTW for the PBS series New Explorers, concentrates on the decline in breeding songbirds of Illinois and their migrations.

Other changes in environments also contribute to songbirds' declines. Recent research has found that high levels of noise from highways, airports and other man-made activities have interfered with the ability of birds to sing breeding songs and breed successfully. Birds that migrate to the Caribbean and Latin America suffer high mortality from collisions with television and cellphone towers and tall buildings. For many years, one scientist at Chicago's Field Museum has collected migrating songbirds that died from flying into a single building near the museum**.** His collection now totals 20,000 birds. He estimates that total mortality from building collisions may be 60 million songbirds a year, an enormous loss.

A great concentration of breeding songbirds is found in Belt Woods, a 500-acre-forest near Bowie, Maryland. Trees that were growing when Columbus discovered America survive here. Perhaps the largest tract of old-growth forest in the region, it has a variety of habitats from swamp forest to dry hardwood stands. More than 40 species of migrant birds nest here, including Wood Thrushes, Rose-breasted Grosbeaks, Baltimore (Northern) Orioles, Scarlet Tanagers, Prairie Warblers and Ovenbirds. These are species that have disappeared from woodlands that have become fragmented, or contain few tall trees. This wealth of breeding birds underlines the importance of protecting old-growth forests. Privately owned, Belt Woods was willed by the late owner, William Seton Belts, to the Episcopal Church to be kept intact in perpetuity. The church, however, went to court in the 1990s to change the will to allow sale to developers, claiming that it had more important works to accomplish with the funds than saving the forest.

After conservationists had decided it was a hopeless cause, a local resident, Pam Cooper, decided to spearhead a rescue of these precious woodlands. By conducting publicity campaigns and fund-raising efforts, she and the Western Shore Conservancy raised money. A Maryland author and illustrator of children's books, Lynn Cherry, organized The Friends of the Woods to enlist children to help influence their parents and public opinion to place the preservation of this threatened woodland above that of sheer materialism and to champion the need to take on local conservation problems as a community. Her children's book, *Flute's Journey, the Life of a Wood Thrush*, chronicled the life of a Wood Thrush born in Belt Woods, its migration to Costa Rica and its uncertain future. The plight of Belt Woods was given national attention in April 1996 on a CBS program, "Sunday Morning," which may have been a crucial turning point in the preservation of this forest. Within months, an arrangement was finalized with conservation organizations that would turn Belt Woods into a reserve, ending the possibility that it would be sold to developers.

At a time when losses in the numbers of North America's beautiful songbirds may have become irreversible, scientific research is revealing that they play a crucial role in controlling insects in forests (Yoon 1994). In a controlled experiment, birds were excluded from a section of forest with netting cages that allowed insects to enter. It was found that trees and plants incurred twice the damage to foliage where birds were excluded (Yoon 1994). The

study concludes that songbirds constitute a major and important form of natural pest management, superior to pesticides (Yoon 1994). Keeping songbirds from nesting in a stand of White Oaks, other researchers found that caterpillars consumed so much foliage that the trees grew significantly more slowly than White Oaks with nesting songbirds (Robinson 1996).

North America™s Forests: Page 2

It would probably shock most residents of suburban New York City to know that 150 years ago, wild Gray Wolves preyed on White•tailed Deer, Eastern Bison and Elk in the dense virgin forests now occupied by their neatly clipped green lawns, while overhead the flight of millions of Passenger Pigeons darkened the sky. The Eastern United States is undergoing a "Europeanization" in which natural forest is being lost to housing tracts, highways and urbanization. This sprawl consumes the second-growth forests, some of which had become excellent wildlife habitat, and the new residents often contaminate the water and soil with pesticides and herbicides to maintain green lawns. The natural world and its fauna and flora are fast disappearing.

Just as they are disappearing, discoveries about the medical potential of eastern forest trees are being made. Recently a fungus was discovered that is a missing link in the life cycle of a mold that produces the billion-dollar drug cyclosporin, used to prevent the rejection of transplanted organs (Yoon 1996). The forest of the Finger Lakes Land Trust in Ithaca, New York, where Cornell University students found the fungus, has established the nation's first reserve set aside specifically for chemical prospecting outside the tropics (Yoon 1996).

Most of the Great Lakes region was originally covered in ancient pines. During the logging boom of the late 1800s, mills of one Great Lakes port alone, Ashland, Wisconsin, cut 500 million board feet of lumber a year (a board foot is equal to wood 1 foot square and 1 inch thick), enough for 50,000 houses (Johnson 1997). Timber barons shipped the lumber to rebuild Chicago after the great fire of 1871, and the logged-over area, covered in broken branches, stumps and discarded trees, ignited a series of fires, one of which killed 1,152 people in the town of Peshtigo, Wisconsin (Johnson 1997). These fires charred millions of acres, leaving a wasteland (Jonas 1993). By the end of the 19th century, the majority of these forests had been clearcut by commercial loggers (Jonas 1993). There remains a scarcity of timber, and in 1996 a treasure trove of 20,000 to 30,000 old-growth tree trunks was found by divers on the bottom of Lake Superior; they had sunk more than a century after being cut and floated to mills (Johnson 1997). Old-growth timber is extremely valuable. It has tight grain resulting from slow growth, unlike the grain in the trees grown on tree farms. These logs are worth many millions of dollars, and a company is bringing the logs to the surface, selling them for ten times the price of new wood (Johnson 1997). These are the last remnants of a once vast forest.

Early in the 20th century, Weyerhauser, the German timber magnate, having logged out the old growth of the Great Lakes area, turned to the forests of the Southeast. Forests dominated by Longleaf (*Pinus palustris*) and Shortleaf Pines (*Pinus echinata*), which have the world's greatest diversity of forest floor plants, dominated northern Florida west to Louisiana and north to central Georgia. Longleaf Pine forest once covered 90 million acres from Virginia to Texas. These forests also harbored Loblolly (*Pinus taeda*), Virginia (*Pinus virginiana*), Pond (*Pinus serotina*) and Pitch Pines (*Pinus rigida*), which grew in various types of soil and climatic conditions. Loggers decimated this ecosystem, cutting millions of board feet, and by the 1930s, these forests had been reduced to a fraction of their original extent. Today, only about 2 percent of the Longleaf Pine forests remain, making them the most endangered forest ecosystem in North America. For the most part, these forests have been replanted with other species, predominantly commercial tree farm monocultures.

Much of the remaining virgin pine forests of the Southeast lie on national forest land, and they are being heavily logged. On December 15, 1995, this destruction was fought by the Biodiversity Legal Foundation and the Alabama Wilderness Alliance, which filed suit in Federal District Court against the US Forest Service challenging the legality

of the Forest Service decision to open a series of massive salvage timber sales of trees blown down by a hurricane, along with some healthy standing trees, on 15,000 acres of the Conecuh National Forest in Alabama. The Biodiversity Legal Foundation hired biologists and other experts, who testified that Forest Service management of the forest violated its own environmental regulation relating to logging near waterways and had planted non-native trees instead of the native species that are preferred by the Red•cockaded Woodpecker (*Dendrocopus borealis*), an endangered resident of this forest. This lawsuit was settled in favor of the conservation organizations.

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A victim of this logging, the Red-cockaded Woodpecker is a small bird marked in black and white and named for the male's tiny streak of red on each side of the nape. These birds have very specific habitat needs. For nesting trees they usually choose old-growth pines stricken with red heart disease whose soft wood permits easy excavation of nesting holes; the sap running down the trunk deters snakes and other predators (McFarlane 1992). Red-cockaded Woodpeckers nest in small groups or clans, requiring large areas of undisturbed forest. Each clan has "helpers," non-breeding birds that aid in feeding the nestlings (McFarlane 1992). These woodpeckers were the primary control of the southern Pine Beetle, a major pest in pine forests; after destruction of old-growth pine forests, which endangered these birds, Pine Beetles proliferated and destroyed other types of pines (McFarlane 1992).

Prior to the commercial logging of the early 20th century, these woodpeckers may have numbered in the hundreds of thousands. Nineteenth century records exist of Red-cockaded Woodpeckers as far north as northern New Jersey and southeastern Pennsylvania, and west to Missouri (Jackson 1994). Gradually, their range shrank as pine forests were destroyed; by 1946 the species was gone from Missouri, and by 1976 from Maryland (Jackson 1994). Populations in Tennessee declined to a single bird by 1992, and they disappeared from northern Mississippi in 1977; Kentucky and Virginia have only a few family groups (Jackson 1994). In the Southeast, clans became rare and widely separated from one another as millions of acres of old-growth pine were logged. When listed on the Endangered Species Act in 1968, programs to prevent its extinction were launched. Inbreeding of Red-cockaded Woodpeckers is apparently occurring in populations isolated by forest fragmentation (Jackson 1994). Some females have been physically translocated to isolated groups without females to counteract this problem (Jackson 1994). Nest holes have been artificially created, and existing nest holes have been modified with steel plates, restricting the size of the opening to prevent predators and larger birds from entering the nest hole (Jackson 1994).

The problem of declining habitat remains, however, and some conservation organizations, including the Biodiversity Legal Foundation, have successfully taken the Forest Service to court concerning their replanting policies, obtaining court orders mandating replanting with Longleaf Pine to benefit the Red-cockaded Woodpecker. At present, only about 30 known clans remain, with South Carolina and Florida having the largest numbers; the entire population of the Red-cockaded Woodpecker may not exceed 7,400 birds (Collar *et al.* 1994).

One haven for the Red-cockaded Woodpecker is Eglin Air Force base, located on the Florida panhandle. This 460,000-acre base preserves the world's largest remnant of Longleaf Pine forest, which occupies 320,000 acres of the base (Stevens 1996); 10,000 acres of this forest are the largest remaining old-growth Longleaf Pine in the world, with many 400-year-old trees (Biondo 1997). The Nature Conservancy has spent years conducting biological surveys and has discovered that more than 90 rare or imperiled species, including a salamander new to science, inhabit the base (Biondo 1997). Eglin protects 1,200 plant species, with numerous threatened species among these. Military activities are carried out as carefully as possible, and the base employs a full-time chief of natural resources with a staff of 25 (Biondo 1997).

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The military conducts munitions tests on Eglin Air Force Base, causing fires that have inadvertently benefited the ecosystem. The piney woods of the Southeast need fire, without which shade-tolerant hardwoods begin to intrude on Longleaf and other native pine stands (Jonas 1993). At present, Eglin officials conduct controlled burns to maintain this habitat (Stevens 1996) and are removing non-native and overabundant plants and trees (Biondo 1997). To return the Longleaf Pines to former abundance, more than 3 million seedlings have been planted, restoring 200,000 acres over the past five years (Biondo 1997).

The Gulf Coastal Plain Ecosystem Partnership, a plan to link populations of Longleaf Pine forests, was formed in 1996 to protect 840,000 acres of contiguous forest held by seven major landowners in northern Florida and southern Alabama (Biondo 1997). The partnership has signed a memorandum of understanding that encourages cooperation between the diverse owners, from private logging companies to state forest departments and water management districts (Biondo 1997). More than 160 rare or imperiled plants and animals reside in these lands, and Eglin Air Force Base's land has been the best preserved of any because of limited human intrusion and very little logging. It also protects a sizeable population of threatened Gopher Tortoises (*Gopherus polyphemus*). This keystone reptile excavates deep tunnels and cavities which provide habitat and shelter during fires for hundreds of animals, including threatened species.

Southern Bald Cypress (*Taxodium distichum*) swamp forests were once found in many low-lying areas of the South, but today, the Okefenokee Swamp is the largest remaining tract. Plans to clearcut this huge forest were abandoned early in the century after logging proved unprofitable. Later, the Okefenokee was declared a National Wildlife Refuge, and it is one of the most important examples of this ecosystem, home to River Otters (*Lutra canadensis*), Alligators (*Alligator mississippiensis*) and abundant water birds.

Massive stands of ancient Live Oaks (*Quercus virginianus*) draped in Spanish moss evoke the very essence of the South. Although the majority of these huge trees have been logged, many survive that are 10 to 12 feet in diameter. They have a dense wood that was used in the construction of ships such as the USS Constitution. This ship was called "Old Ironsides" because this hardwood was impervious to cannonballs. The last sizeable stands of these picturesque trees are disappearing, however. Companies are buying wood lots with Live Oaks, cutting and replacing them with tree farms of fast-growing pine. As an added threat, a fungus first identified in the 1940s as "oak wilt," has been killing many Live Oaks. The disease chokes the flow of water into the tree and gradually kills it from the inside out, spreading through root connections which link Live Oaks growing in close proximity. In Texas, where this disease has killed many of these oaks, the Texas Forest Service has been successful in injecting chemicals that kill the fungus and digging trenches that break connections between these oaks.

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Predators of the Southeastern forests declined or disappeared after European settlement as a result of overhunting and persecution, leaving an imbalance in which White-tailed Deer proliferated without Grey Wolves or Mountain Lions to limit their numbers. Both the latter predators remain absent in the eastern United States, although there are unsubstantiated sightings of Mountain Lions in Maine and elsewhere. A few Grey Wolves have entered northern Maine in recent years, and some conservation organizations have proposed reintroductions of the species into Adirondack Park in New York state or in northern New England. Red Wolves (*Canis rufus*) were totally eliminated by predator control programs and hybridization with the Coyote, reaching extinction in the wild by 1973 when the last

wild members of the species were taken into captivity. This uniquely American species, which until recently was considered to have been native to only the southeastern United States, is now thought to have been distributed throughout eastern North America, based on DNA testing showing close relationships between the Red Wolf and wolves of eastern Canada, which have managed to persist to the present. The species was larger in northern states and preyed on deer and elk. Red Wolves survive today as a result of the 14 animals that formed the nucleus of the Fish and Wildlife Service's breeding colony. By 1993, more than 233 animals resided in 31 breeding facilities. Several successful releases have taken place in North Carolina and other eastern states, and about 100 Red Wolves survive from these releases.

West of the Mississippi River, pine forests in the mountainous regions of the Southwest were also heavily logged. A resident of these forests, the southern Mexican Spotted Owl (*Strix occidentalis lucida*), a race of the Spotted Owl, whose northern race inhabits old-growth forests of the Pacific Northwest, has become very rare. This owl, like its northern relative, requires undisturbed forests. The dominant tree of the southwestern forests is the Ponderosa Pine (*Pinus ponderosa*), which towers 180 feet tall and can live 500 years (Jonas 1993). Originally, these trees covered hundreds of thousands of acres in northern Arizona, New Mexico, and neighboring states; old-growth pine forests also stretched south into northern Mexico. Beautifully adapted to the dry, mountainous habitat, Ponderosa Pines often grow in large, pure stands. These forests have very little old growth left today, and Mexican Spotted Owls have disappeared from national forests in Arizona and New Mexico after the oldest trees were logged (Johnson 1995).

Many unusual and endemic species live in pine and juniper forests of the Kaibab Plateau on the north rim of the Grand Canyon. The Kaibab Squirrel (*Sciurus aberti kaibabensis*) is confined to this plateau. This beautiful squirrel is considered by most authorities to be a subspecies of Abert's or Tassel-eared Squirrel, but some zoologists treat it as a separate species. One of the most dramatic looking of all squirrels, the Kaibab is dark brown, with long tassels on its ears, and a snow-white bushy tail. Its close relative, Abert's Squirrel, is dark, grizzled gray on its back and tail. Feeding mainly on conifer seeds, these squirrels suffer high mortality from hunting, road kills and natural predation by hawks (Whitaker 1980). Their habitat is restricted, and they are considered a rare and endemic animal. Ecologically, these squirrels are important in helping the Ponderosa Pine reproduce. They dig for truffles and absorb their spores, which enter their feces. When their feces are deposited near Ponderosa Pines, they spread the spores to the tree's roots, which grow into a fungus, triggering the tree's reproductive biology. In the spring of 2000, wildfires raged through their habitat, undoubtedly causing the squirrels high mortality.

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The problem of illegal logging is growing in the national forests, and a recent threat is the invasion of forests by drug growers. These people have entered roadless federal lands in the West and are seldom detected because of the remoteness and size of many of these tracts. In Los Padres National Forest, they destroyed large sections of forest in 1995 and 1996 to plant marijuana. After cutting trees, they cleared brush with herbicides which killed native plants, many of which are rare and protected. They also diverted scarce water from streams to irrigate their plants, which eliminated native plants dependent on that water. The drug growers put out poison to kill animals, such as deer, they feared might eat the marijuana. This situation presents a major threat to many species of wildlife, and especially to California Condors, who have been reintroduced to Los Padres National Forest and feed on carrion.

Ancient old-growth pine forests covered much of northern Mexico until a few decades ago. Large-scale logging has been felling these great trees, and what reserves have been set aside to protect the remaining patches of old growth are not carefully patrolled to guard against illegal logging. The Imperial Woodpecker (*Campephilus imperialis*), the world's largest woodpecker and one of the most beautiful, declined to extinction as a result of failure by both the Mexican government and private conservation organizations to preserve its habitat. Its decline began from hunting, and logging removed its feeding and nesting habitat during the first half of the 20th century. Several of these birds

were sighted in the 1990s, but because no emergency action took place to preserve these birds in their last retreat, they disappeared. Each pair of Imperial Woodpeckers required a habitat of at least 25 square kilometers, and no area of old-growth forest this large now remains in the Sierra Madre Occidental (Lammertink 1996). Only a few fragments of old growth survive in this huge area, and even these are in imminent danger of being logged.

Mexican logging companies offered local people $2,000 per household for permission to log, and this may have been the deciding factor that led to the end of Mexico's old-growth forests. All that remains of the Imperial Woodpecker are museum specimens. A photograph of three specimens was recently published in the article, "The Lost Empire of the Imperial Woodpecker," in *World Birdwatch* (Lammertink 1996). Martjan Lammertink concluded after his field survey that if the Imperial Woodpecker still exists, no breeding habitat remains and, at most, one or two solitary birds may be left who must fly over huge areas to find food (Lammertink 1996).

A courageous defender of the Sierra Madre forests, Mexican activist Edwin Bustillos has risked his life to fight the drug lords who have taken over large areas in these forests for cultivation of drug plants. In several incidents, Bustillos had five ribs and his arm broken and spent a month in the hospital from injuries sustained when attacked by drug dealers. In 1996, he received the Goldman Environmental Award for his long-term efforts on behalf of these endangered forests.

A beautiful parrot also inhabits these same pine forests. The Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*) once flew in large flocks in search of pine seeds, but its populations have declined from loss of old-growth forests and illegal shooting. The species is listed on the US Endangered Species Act, as endangered by the *2000 IUCN Red List Species*, and on CITES Appendix I, which bans all commercial trade. These large green parrots have red feathers on their foreheads, shoulders and thighs, and bare skin surrounding their yellow eyes. Their large hooked beaks aid them in prying open pine cones. Native to Sierra Madre Occidental of eastern Mexico and, originally, pine forests in Arizona, Thick-billed Parrots live mainly above 2,000 meters. Heavy logging of old-growth pine forests has destroyed 99 percent of its habitat and removed the huge, old trees it needed for nesting (BI 2000, Collar *et al.* 1994). A field survey in 1994 in southern Chihuahua uncovered massive forest destruction and the penetration into its habitat of drug-growers, cattle and loggers (Collar *et al.* 1994). Populations have declined from flocks of thousands seen in the 1950s (Lammertink 1996) to about 5,000 in 1992 and only 1,000 to 4,000 in 1995 (BI 2000). Reintroductions into Arizona of captive-bred birds have not been successful because the birds did not know how to avoid predators or forage for pine seeds (BI 2000).

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Some highly threatened birds persist in unlogged portions of northern Mexico. The beautiful, iridescent Eared Quetzal (*Euptilotis neoxenus*), for example, was formerly common but is now confined to corridors of unlogged trees along rivers. These bits of forest are, at the present at least, inaccessible to loggers (Lammertink 1996). These quetzals require large trees for nesting and lay their eggs in cavities created when large tree snags fall off. Such trees, however, are rare and may disappear altogether in the future, since loggers cut them down as a general rule. It is considered Near-threatened, and close to qualifying as Vulnerable by BirdLife International (BI 2000). The Tufted Jay (*Cyanocorax dickeyi*) is another striking bird with a stiff, bristly, black fan crest on his head and forehead, unlike any other jay. This species is endemic to a limited area in the southern Sierra Madre Occidental, in mixed forested hillsides of oak, dense evergreen and deciduous forest near watercourses. Although a Near-threatened species (BI 2000), it has, nevertheless, no protected reserve.

Pine forests extend south to central Mexico, and up to 30 million Monarch Butterflies (*Danaus plexippus*) from the eastern United States and Canada migrate up to 2,000 miles to several groves of fir trees where they spend the winter clinging to branches in a semi-torpor. These butterflies constitute 90 percent of the species' population, and scientists

believe that they have wintered here for more than 10,000 years (Aridjis and Brower 1996). Their migration is a biological mystery and unique among butterflies. Until the fir groves, where they festoon the tall trees like dazzling orange and black ornaments, were discovered, no one knew where they spent the winter. Even now, their method of locating this particular forest remains unknown. The butterflies that fly south are third generation ancestors of the ones who wintered in Mexico the previous year. On warm days, they wake from their torpor and venture out to take nectar, and in the spring, they head north, breeding along the way (Pyle 1981).

Entirely dependent on these groves of firs, which shelter them from the freezing rains that fall in this high-altitude forest, the Monarchs are threatened by logging. In spite of a 1986 order by Mexican President Miguel de la Madrid to protect the five wintering populations, all located in close proximity, the surrounding trees were not given protection. Local people cut trees for fuel and building materials, and cattle trample fir seedlings (Aridjis and Brower 1996). They have logged up to the very limits of the groves, and without the protection of bordering trees, the butterflies are more vulnerable to cold spells, dying in unprecedented numbers. Snowstorms and cold weather killed millions of these fragile butterflies in 1991 and 1995.

Ann Swengel and Dr. Paul Opler, who coordinate nationwide butterfly counts for the Xerces Society, a butterfly conservation organization, began noticing declines in Monarch populations in the United States, and scientists have seen many declines in areas where they were previously abundant.
Conservation of the precious fir trees upon which the species winters is a key to saving this species. Dr. Lincoln P. Brower, professor of zoology at the University of Florida and a leading authority on the species, and Homero Aridjis, President of the Group of 100, a Mexican environmental organization, made a public appeal for the protection of the Monarchs' winter habitat in an Op-ed article for *The New York Times* in January 1996 (Aridjis and Brower 1996). They maintained that all three countries--the United States, Canada and Mexico--should cooperate to purchase the forests in keeping with the North American Free Trade Agreement (NAFTA) (Aridjis and Brower 1996). A comparison of forest cover in the Monarch groves based on aerial photographs taken in 2000 and in the 1950s, shows great losses in these protected trees from illegal logging over the past 40 years. The situation has reached crisis proportions, according to scientists. In response, the Mexican government has promised to protect the remaining groves and enlarge the reserve. Local people have expressed opposition, however, as they have traditionally logged the forests and have not profited from the tourists who come to see the butterflies. If this situation is not resolved in favor of the butterflies, these beautiful jewels that brighten fields and gardens may disappear from their breeding grounds in the United States.

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The ancient forests of the West Coast once stretched from northern California nearly unbroken through coastal Canada to southeastern Alaska, covering 70,000 square miles. Logging by Europeans began in the 19th century, and as the forests fell, a few voices were raised in protest. Even Horace Greeley, a promoter of "progress" and settlement of the West, exhorted Americans in 1851 to "spare, preserve and cherish some portion of your primitive forest" (Peck 1990). It was the fiery Scottish wilderness advocate John Muir who finally succeeded in convincing the US government to protect some of these ancient forests. He settled near California's Yosemite wilderness in the 1860s and began passionately denouncing the destroyers of nature, from loggers to livestock operators. Muir pointed to the political influences that allowed destruction to occur. During the 19th century, livestock swarmed in great numbers over wilderness areas. Muir described sheep as "hoofed locusts" and, in trying to get them removed from Yosemite, said, "As sheep advance, flowers, vegetation, grass, soil, plenty, and poetry vanish" (Peck 1990). When he saw the ancient Sequoias being cut, Muir was outraged:

Through all the wonderful, eventful centuries since Christ's time--and long before that--God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but He cannot save them from fools--only Uncle Sam can do that.

Muir proved to be an adept politician, making friends with influential magazine editors and railroad magnates; President Theodore Roosevelt camped out with Muir in Yosemite in 1903 (Peck 1990). Through Muir™s influence, Yosemite became a national park in 1906, followed by Sequoia, Mt. Rainier, Crater Lake, Glacier and Mesa Verde National Parks (Peck 1990). In 1892, Muir established The Sierra Club conservation organization. If not for Muir's courageous and effective work on behalf of these forests, it is likely that very little old-growth forest land would remain today.

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These centuries-old trees, often covered in epiphytes, plants that get nutrients from moisture and air, and lichens, including one species that drapes over branches in delicate, lacy strands, exude a lushness reminiscent of tropical rainforests. More than 140 inches of rain per year produce luxuriant tree growth and a verdant understory of ferns and hardwoods. Bright green mosses and masses of ferns carpet the ground, and a great variety of mushrooms and lichens flourish in the damp environment. In the spring, the forest floor is carpeted with beautiful white trilliums and other flowers that contrast with the deep greens of the forest. Mist and fog enshroud the giant trees, which intercept the moisture from the atmosphere, supplying the trees and the entire environment with water throughout the year (Ellis and Kane 1991).* The southern portion of these forests is dominated by Coast Redwoods, with the record tree reaching more than 365 feet in height. Its upper branches are more than 50 feet in length. They are among the most ancient as well, some over 2,000 years old (Middleton 1992). The great Redwoods of northern California gradually melt into a forest of mixed pines, fir, cedars and hemlock.

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*Along with the fine book by D. Middleton (1992), cited frequently here, *North America's Rain Forest. The Endangered Paradise*, by Gerry Ellis and Karen Kane (NorthWord Press, 1991), is an excellent resource, beautifully illustrated with the trees, plants and wildlife of these forests, and shows the devastating clearcuts contrasted with living forests. *Western Forests*, a book in the *National Audubon Society Nature Guides* series illustrates most wildlife and plant species, as well as discussing forest ecosystems.

Douglas Firs (*Pseudotsuga menziesii*) grow to ages of 700 to 1,000 years old in climax growth, veterans of hundreds of periodic fires; they may reach 325 feet in height (Jonas 1993). A tree 250 years old is considered young in an old-growth forest, while middle age is 400•500 years, and old age is more than 700 years (Middleton 1992). Recent research conducted in these forests indicates that rich diversity does not develop until forests are at least 200 years old (Moffet 1997).

Ancient Red Cedars (*Thuja plicata*) grew in abundance in these old-growth forests and were among the first to be cut by loggers. Old specimens are very rare at present, and activists recently saved one area with many exceptionally old and massive cedars from being logged. This forest, in Upper Priest Lake, northern Idaho, has cedars 1,500 years old. The largest trees are 20 stories tall, with trunks 10 feet in diameter. The ground beneath is carpeted with ferns, including the largest population of Braun's Holly Fern in the West. Old-growth cottonwoods also grow here. Endangered Woodland Caribou (*Rangifer tarandus caribou*), threatened Grizzly Bears, Fishers and Wolverines, rare Cutthroat Trout, endemic salamanders, and Harlequin Ducks are resident in the forest and wetlands. This forest covers 520 acres, worth at least $9 million to the lumber company that owns it. The US Forest Service was unable to

obtain federal money to purchase it in 1996, and not until October 1997 was the grove preserved through a trade of land worth $8.7 million between the owner and the Forest Service.

More than 1,000 plant and animal species depend on old-growth forests (Egan 1994a). Invertebrate animals of the soil are highly diverse: an area 1 meter by 1 meter shelters 200,000 mites of 75 species (Middleton 1992). Fallen logs may take 500 years to rot, and this decaying wood is fed upon by the most diverse fungal network in the world (Middleton 1992). The hollow logs are used as nest holes by Red•backed Voles and other small species. The young of these voles feed on truffles that grow in the rich soil. At least 300 insect species have been described from the rotting•log community of organisms (Middleton 1992). A host of other insect species of the forest canopy have yet to be described.

Many vertebrates depend on the old-growth forests of the Pacific Northwest for their survival, and some of these live nowhere else. The Sitka Black•tailed Deer and Roosevelt Elk and a unique bluish strain of American Black Bear from southeastern Alaska are among these. Bats of several species--Long•eared, Hoary and Silver•haired--are major pollinators and insect-predators in forests of the Pacific Northwest. Roosting in the hollow trunks of ancient trees, these bats have declined in many areas because of logging. A great diversity of amphibians lives in the moist environments of these temperate rainforests. Among them are the Slender, Olympic, Pacific Giant and Del Norte Salamanders, Pacific Tree Frog and Tailed Frog.

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The Northern Spotted Owl (*Strix occidentalis caurina*) may be the most famous resident of these forests. The struggle over old-growth forests became a bitter controversy focused on the fate of this bird, which was declared a Threatened species under the Endangered Species Act in June 1990. This owl is native to old-growth forests in northern California, Oregon and Washington, and each pair of owls requires up to 3,200 acres as territory, making it a naturally rare species (Middleton 1992). Northern Spotted Owls nest in natural tree cavities or holes created when great branches from living trees fall to the ground. The canopy above shields owlet chicks from the view of large birds of prey that fly above. These owls feed on the Red Voles, Dusky-footed Wood Rats and Northern Flying Squirrels that are abundant in old-growth forests. When these forests are cut and young second-growth forest takes over, Spotted Owls disappear (Seideman 1997). In spite of the protection of portions of their habitat, these owls have not recovered their numbers since listing on the US Endangered Species Act, and they continue to decline. The US Forest Service released extensive data compiled on the populations of these birds between 1985 and 1993, which showed a drop of 4.5 percent a year, with an accelerating rate of decline (Seideman 1997). Another threat to these owls is the recent invasion of their habitat by the larger and more adaptable Barred Owl, which is displacing the Spotted Owl in some areas. Even more ominously, interbreeding has taken place between the two species (Seideman 1997).

When the Northern Spotted Owl was listed as Threatened on the Endangered Species Act and large sections of its habitat protected, it became a focal point, polarizing pro-logging and anti-logging advocates. Owl haters urged others to kill these birds, who were blamed for ending the logging industry. Their cars sported bumper stickers such as "Kill an Owl, Save a Job." Such venom totally obscured the fact that the forests were being overcut and that logging jobs were destined to be eliminated anyway, as the last old-growth forests disappeared under the saw. A state in the heart of this owl's range, Oregon, found that reducing logging ended up helping its economy; an influx of technology businesses provided better salaries than those paid for logging jobs (Egan 1994b, Verhovek 2000). The Governor of the state supported the logging restrictions as helping to maintain the overall quality of life in the state, preventing

floods and attracting tourists, which are supplying another large segment of the state's revenues.

Habitat Conservation Plans (HCPs), authorized under the Endangered Species Act may be contributing to the Spotted Owl's decline. Under these plans, agreements are negotiated with landowners which include a provision known as "no surprises." This gives landowners assurances that once the regulations on their properties have been agreed to, they are exempt from further restrictions. Should new populations of an endangered species be discovered on their property, they have no obligation to protect them. Habitats of Spotted Owls in old-growth forests in Washington State have been bartered away in HCPs that, in the view of Eric Hanson, biologist for the Yakima Indian Nation in Washington state, will end in reducing the state's populations of this species by 35 percent, from 880 breeding pairs to 550 (Seideman 1997). These HCPs allow habitat destruction and other actions that can result in deaths of Spotted Owls. The Forest Service collected population data on these owls for the years between 1994 and 1996 but failed to issue the results (Seideman 1997).

The Clinton Administration sponsored a series of local meetings to resolve differences. These resulted in plans to federally fund job•training for loggers who might become unemployed by logging cutbacks. Even so, logging interests sued the federal government to nullify the stricter quotas, and the California Forest Products Association unsuccessfully petitioned the Fish and Wildlife Service in October 1993 to remove the Northern Spotted Owl from the Endangered Species Act, claiming the species was mistakenly placed on the list. This case was argued all the way to the US Supreme Court which, in the summer of 1995, made a historic decision upholding the Endangered Species Act and its protection of endangered species' habitats.

The Timber Salvage Act of 1995 made a mockery of previous attempts to mediate between loggers and conservationists, allowing a year and a half of totally unregulated logging in the habitat of the Northern Spotted Owl and other threatened species. This law had the stated purpose of taking only fallen and dead trees, but in practice, tens of thousands of old-growth, healthy trees were logged. In its quarterly report on the Timber Salvage Act, issued February 29, 1996, the Forest Service reported that an astounding 2.1 *billion* board feet had been cut since passage of the law. The Forest Service's stated objective was to sell 4.5 billion board feet by the end of 1996. By August 1996, some 2.9 billion board feet, the equivalent of 580,000 logging trucks full, had been cut under the Timber Salvage Act (Bass 1996). National forest lands to be logged totaled at least 50 million acres. Major habitat areas for many endangered and threatened species were among these lands. Fortunately, this law expired at the end of 1996.

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The Marbled Murrelet (*Brachyramphus marmoratus*) is also dependent on old-growth forests and has been seriously impacted by the logging that, since the 19th century, has destroyed 95 percent of its old-growth habitat in the US Pacific Northwest. This small, black-and-white seabird is a Threatened species on the US Endangered Species Act and is listed as Vulnerable by BirdLife International. Unlike any other seabird, this Murrelet nests high in the branches of 200- and 300•foot trees. Sometimes seen in offshore waters of the Pacific Northwest and Alaska, their nests are rarely found. In fact, only about 30 nests have ever been located in the Pacific Northwest--all high in the

crowns of old-growth forest trees.

A researcher who was studying the ecology of old-growth tree canopies made an exciting discovery of a Marbled Murrelet nest. He photographed the adult on its nest, made of lichens, with a small fish in its mouth for its chick for *National Geographic* magazine (Moffett 1997). Despite surveys up and down the Pacific coast, this was one of the few nests found in 1996, and plans for logging near the nest site were stopped (Moffett 1997). A prime area for Marbled Murrelets is the Olympic National Forest in Washington state where large tracts were sold for clearcutting in 1996 under the Timber Salvage Act. In Umpqua National Forest, Oregon, over the weekend of March 23-24, 1996, several thousand-year-old Douglas Firs were cut; their age was determined by coring and ring counts. The Umpqua River has endangered populations of Coho Salmon (*Oncorhynchus kisutch*) and sea-run Cutthroat Trout, and logging may eliminate them. The Marbled Murrelet's nesting trees are being logged throughout the species' range. A few areas have been protected in Alaska, but they are declining rapidly, at a rate of 31 to 48 percent per decade, with little hope that sizeable areas of old-growth forest will be protected (BI 2000).

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The Pacific Yew (*Taxus brevifolia*)**,** found only in these forests of the Pacific Northwest, is considered a "trash species" by foresters who clear it away to make room for more valuable species. This plant grows in the undergrowth of old-growth forests from California to southeastern Alaska (Jonas 1993). It has recently been shown to contain a chemical substance, Taxol, that has proven effective in treating ovarian and other cancers (Middleton 1992). A rush to cut these trees and strip their bark to obtain Taxol threatened them with extinction until the chemical was successfully produced synthetically. Taxol will be a major new tool in treating cancers and will result in sales totaling many millions of dollars for the pharmaceutical industry.

These discoveries have taken place as the fate of the last stands of old-growth forests is hanging in the balance. Ninety-five percent of these forests in the United States, and more than 60 percent in Canada, have already been cut. Opposition to clearcutting is increasing, however. Lewis H. Nash is a member of an organization known as the "Environmental Air Force," which chronicles illegal cutting of Coastal Redwoods. Members pilot small planes over clearcuts and document the damage with photographs. Nash's work enabled an environmental lawyer to obtain an injunction in 1995 stopping logging the same day (Goldberg 1996a). In 1996, flying over the devastated forests of northern California, Nash remarked: "When I first started flying here 10 or 15 years ago, this was all the same, all primeval forest. All this has been pretty well hacked over" (Goldberg 1996a).

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One of the most heated debates over these forests involves the last privately-owned large tracts of redwoods. Commercial exploitation began in 1900 when Frederick Weyerhauser purchased 900,000 acres for $6.00 per acre, a ludicrously low price even in those days (Dietrich 1992). Almost all privately owned old-growth forests became depleted by the 1960s. One exception was a large tract of old-growth Coastal Redwoods and Douglas Firs in California's Humboldt County, in the northern part of the state, owned by the Pacific Lumber Company. This family-operated company had left most of its 200,000 acres intact and had been particularly protective of the most ancient trees in the 55,000-acre Headwaters Forest. In 1986, however, Houston financier Charles Hurwitz took over Pacific Lumber, using junk bonds. Hurwitz's United Savings Association of Texas failed, costing US taxpayers $1.6 billion, part of the savings-and-loan collapse (Brown and Stark 1995).

To pay his debts, Hurwitz began clearcutting the old-growth Coast Redwood and Douglas Firs. By 1995, he had

cut 40,000 acres of the Headwaters Forest and nearby old-growth trees, leaving only 5,500 acres of virgin Coastal Redwood and 5,000 acres of virgin Douglas Fir (Brown and Stark 1995). This is one of the most extreme cases of abuse of private land in the history of this country. Two-thousand-year-old trees were turned into picnic tables, lawn furniture and patio decks. Logging was delayed by several lawsuits, and to protect nesting sites of Marbled Murrelets, the California Forestry Department recommended in 1995 that Hurwitz be refused permission to build a logging road into the 4,400-acre grove of the most ancient trees (Brown and Stark 1995). Two California Congressmen, George Brown and Pete Stark, proposed that the federal government engage in a debt-for-nature swap, in which the Federal Deposit Insurance Corporation, which has sued Hurwitz for his role in the failure of his bank, would, through a special arrangement set up by the President, exchange the redwoods for his debt (Brown and Stark 1995). Hurwitz rejected the idea, calling it a "so-called fantasy of debt for nature" and threatened lawsuits against the government for excessively limiting the use of his land (Goldberg 1996b).

The value of the Headwaters Grove is estimated at between $100 and $500 million, with many giant trees several thousand years old and 12 feet in diameter; individual trees are worth more than $100,000 each (Goldberg 1996b). The ecological and esthetic values, however, are inestimable. Hurwitz called environmentalists who blocked sale of these trees "extremists" and insisted that he expected to be paid "fair market value for these trees" (Goldberg 1996b). Acrimonious negotiations for the grove continued in 1996 and 1997, with environmentalists demonstrating against an agreement negotiated that would protect only 7,500 acres, instead of the 100,000 they wanted saved. Early in 1997, Hurwitz demanded that he be paid in cash rather than land that was offered by the state of California, land which many environmentalists thought should be protected (Golden 1997). The deal arranged with Hurwitz allowed extensive cutting of the remaining 100,000 acres of old-growth forest without regard for endangered species' habitat.

Members of Earth First! began protests, entering the land and attempting to block logging trucks, and a young conservationist, Julia Hill, who became known as Julia "Butterfly" Hill, climbed up near the top of an ancient redwood tree she called Luna and refused to come down. She stayed up in this tree for two entire years, until the spring of 2000, while trees were cut in the surrounding area, until a sum of $50,000 was paid to the Hurwitz lumber company for Luna and 2.9 acres of surrounding forest, which were donated to Humboldt State University. She came down from the tree at last, a symbol of the extreme devotion and zeal that have been expended in attempts to preserve these ancient trees. The forest will continue to be cut, however, which will be a permanent loss to the environment and a stain on state and federal governments for not taking a stronger role to preserve the entire forest.

In a sad footnote, in November 2000, a vandal sawed a cut 32 inches deep and stretching 19 feet, or half the circumference, across the base of Julia Hill's tree, Luna. It appeared to have been done by a professional logger, judging from the precision of the cut. A team of specialists--an arborist, an engineer and a forester--was convened to try to save the tree (Quinn 2000). Metal braces were drilled into the tree spanning the cut. All efforts are being made to save this ancient tree from falling in winter storms. Visitors are being asked to stay away because the soil and hillside are being deeply eroded. It is a symbol of the senseless destruction of ancient forests.

Only 4 percent of the once vast and magnificent Coastal Redwood forests remain. These trees covered at least 2 million acres prior to logging, but only about 84,000 acres of virgin redwoods have been protected in state parks and the Redwood National Park; another 66,000 acres of logged and second-growth redwoods have been set aside (DiSilvestro 1990).

North America™s Forests: Page 14

Another major conservation struggle involves the magnificent Tongass National Forest in southeastern Alaska. This forest, covering 17 million acres, is the country's largest national forest--a mosaic of glaciers, mountains, fjords and islands covered by ancient trees. It makes up half of one of the largest remaining temperate rainforests on Earth,

which extends 1,000 miles in an arc along the southeastern coast. At least 6 million acres of Tongass are--or were--old-growth rainforest (DiSilvestro 1990). Sitka Spruce, Western Hemlock, and Red and Yellow Cedar many hundreds of years old dominate the forest.

The Tongass is home to a number of rare animals. Approximately 10,000 Bald Eagles nest in the tops of trees (DiSilvestro 1990). More Grizzly Bears live in the Tongass than in the entire lower 48 states, denning in the holes of towering old trees. A race of the Grey Wolf known as the Alexander Archipelago Wolf (*Canis lupus ligoni*) inhabits the Tongass; numbering only about 1,000 animals, its population is in decline (Williams 1995). Logging threatens these wolves and rare wildlife, including the Queen Charlotte Goshawk (*Accipiter gentilis laingi*) and the Marbled Murrelet (FWS 1994). The Wolf and the Goshawk are candidates for listing on the Endangered Species Act. These and other species of this beautiful area cannot survive in clearcuts and logged-over forests. The American Rivers organization has listed Tongass's Thorne River as one of the 10 most endangered in the United States, having become silted and its banks eroded from logging (Williams 1995).

The cutting of the Tongass's giant trees began in 1833, and by 1926, six sawmills were operating; by 1930, most of the lowland and easily accessible timber and giant old trees had been cut (DiSilvestro 1990). In the 1950s the Forest Service allowed cutting of ancient trees in rugged, steep areas and opened the way for a wood pulp industry to be fed by clearcutting. The Service offered two 50-year contracts at bargain-basement prices, instead of the usual three- to five-year contracts (DiSilvestro 1990). It signed an exclusive contract with the Ketchikan Pulp Corporation and, unlike other national forests where contracts are open to bidding, this contract was awarded during secret meetings from which the public and conservation organizations were excluded. From this time onward, 200 million board feet or more of old-growth forest were logged annually from the Tongass National Forest (DiSilvestro 1990).

The Alaska National Interest Lands Conservation Act of 1980 divided most of the state among federal, state and native interests. Within the law was a provision requiring maximum logging levels in the Tongass National Forest, with the quota of 4.5 *billion* board feet to be logged every decade, with annual subsidies of $40 million from the federal government for logging roads and other aid to timber companies (DiSilvestro 1990). In the 15 years that followed, billions of board feet were logged in this magnificent rainforest, at a financial loss to the taxpayer.

National organizations, including the Taxpayers for Common Sense based in Washington, DC, criticized the clearcutting of this and other national forests which provide no income to the federal treasury and are entirely subsidized by public funds (Schmitz 1996). A 1995 General Accounting Office report found that Tongass's Timber Program was the biggest money loser in the National Forest system, with a negative net return of $102 million to the US Treasury between 1990 and 1994 (Schmitz 1996). More recently, a study by the John Muir Project found that in the years 1997 through 1999, the National Forest Service Timber Sale Program operated at a net loss to taxpayers of more than $3.3 billion (Hanson 2000). This research found that less than 3 percent of the country's total annual wood consumption, and less than 4 percent of the sawtimber used for construction, comes from national forests (Hanson 2000). A nationwide poll in 1998 found that 69 percent of Americans oppose allowing timber companies to log the national forests (Hanson 2000).

The fight to save these forests is being waged in the courts, with public criticism and legal actions brought by conservation organizations. A 1987 book, *The Tongass. Alaska's Vanishing Rainforest*, dramatically illustrated the great beauty of this forest and the ravaging effects of logging, including clearcuts on steep, erodable slopes. This publication served as a catalyst for the passage of the Tongass Timber Reform Act of 1990 that stopped the $40 million subsidy to loggers and set aside 1 million acres to be closed to logging (Ketchum and Ketchum 1994). It did not stop or appreciably slow logging elsewhere in Tongass, however, and called for 150 million board feet a year to be cut. The book was updated in 1994 and described the continuing bitter battle being waged to protect this vast area (Ketchum and Ketchum 1994). In 1997, the heavily polluting Ketchikan pulp mill was finally closed. The Forest Service's 10-year plan for Tongass National Forest, finalized in May 1997, opened up 670,000 acres to logging, authorizing the cutting of 220 million to 267 million board feet of timber annually (this is enough to load 50,000 logging trucks or build more than 20,000 houses a year) (Cushman 1997). The Forest Service stated that the portion

of land that would be set aside would make it unnecessary to list the Alexander Archipelago Wolf and the Queen Charlotte Goshawk on the Endangered Species Act. Conservation organizations criticized the plan and the failure to support listing of these species. The Alaskan Congressional delegation expressed its disappointment that more timber had not been open to logging (Cushman 1997). The 100- to 125-year cycle of cutting by the Forest Service assured that old-growth forests and their complex and diverse ecosystems will disappear.

The Forest Service held nationwide hearings during the summer of 2000 regarding a proposal that some 50 million acres of national forests be protected from road-building. This proposal specifically exempted the Tongass National Forest. The Forest Service plan would allow massive road construction and logging in the Tongass's remaining pristine forests. In a surprise decision prior to leaving office, President Bill Clinton authorized the inclusion of 9.3 million acres of the Tongass National Forest in the final plan; although delayed until 2004, this was an extremely important event, condemned by the Alaskan Congressional delegation (Hughes 2000). The plan calls for $13 to $20 million to be spent in Alaska creating jobs lost in the timber industry. The plan had drawn more than 1.5 million letters and e-mail messages, the overwhelming majority in favor of banning road-building. In spite of opposition to the designation of wilderness in this vast national forest, conservationists succeeded in obtaining a moratorium on logging of 9 million acres, pending the results of studies on whether they qualify for permanent protection under the Wilderness Act (Earthjustice Legal Defense Fund 2001).

Another huge national forest in Alaska, the Chugach, located at the headwaters of the salmon-rich Kenai River, has received far less attention than the Tongass, in spite of being the second largest of all US National Forests. In 1996, the Forest Service cut nearly 16 million board feet in this old-growth forest.

North America™s Forests: Page 15

The future of forests in the United States is at a dramatic turning point. During the summer of 2000, devastating wildfires broke out in the Western United States, primarily in national forests. More than 6.7 million acres burned, along with hundreds of private homes (Janofsky 2000). Within months, the Clinton Administration proposed a major new approach to the national forests, dictating extensive thinning of millions of trees and the removal of brush to prevent future wildfires (Jehl 2000). This plan was based on the theory that the fires were caused by too little logging, resulting in dense forests with underbrush that caught fire and spread uncontrollably. Pro-logging Members of Congress, western Governors and logging companies immediately endorsed the plan (Janofsky 2000, Jehl 2000). Some Governors wanted even more money for the program (Janofsky 2000). The proposed thinning would cost taxpayers $12 billion over 15 years (Jehl 2000). This was challenged by a report issued by the Congressional Research Service soon after the fires were extinguished, which concluded that there was no connection between the level of logging and wildfires (Egan 2000). Other critics included the Forest Guardians of New Mexico, who contended that the fires were the result of decades of industrial logging in which the largest trees were taken; it suggested that instead of thinning, logging subsidies be directed at badly needed projects to control soil erosion, protect water quality and enhance wildlife habitat (Hitt 2000). Environmental groups opposed the logging portion of the proposal as a tool for fire prevention (Janofsky 2000).

As the ideal example of how national forests should be managed, the Clinton Administration proposal pointed to an Arizona Ponderosa forest that had been thinned and did not burn. Ponderosa forests are not typical, however, of all forests, tending to be open with little understory. Other types of forests, such as old-growth temperate rainforests, are not open, and drastic thinning of their undergrowth would result in more, not fewer fires. Moreover, nutrients would be lost, erosion encouraged and wildlife habitat destroyed by such thinning. Dr. Paul R. Epstein (2000), a scientist with Harvard's Medical School Center for Health and Global Environment, concluded that the wildfires were precipitated by global warming, which caused the drought that dried out these forests, making them vulnerable to wildfires. Epstein proposed that the most important reaction to these fires would be to control global warming and

restabilize the climate system.

An extremely important policy statement was made by Forest Service chief Mike Dombeck in January 2001, when he ordered the protection of the largest and oldest trees on Forest Service land (Jehl 2001a). In explaining his decision, Dombeck said, "In the future, we will celebrate the fact that national forests serve as a reservoir for our last remaining old-growth forests and their associated ecological and social values" (Jehl 2001a). Only about 3 percent of national forests is old-growth forest, yet these forests are among the most important refuges for rare and endangered species. Dombeck's statement and the philosophy behind it are reminiscent of John Muir or Henry David Thoreau, an extraordinary reversal from the utilitarian view of forests as tree farms that has held sway since the beginning of the Forest Service. In fact, it had been Forest Service policy that the oldest and biggest trees be cut first (Jehl 2001b). The new Republican Administration and the Senate panel overseeing the Forest Service announced that hearings would be held on the new policy, which runs counter to the one backed by President George W. Bush (Jehl 2001b). Dombeck was asked to leave his job soon after President Bush took office. Logging in national forests has declined from 1989, when 12 billion board feet were cut, to about 3 billion board feet in 2000 (Jehl 2001b). Loggers are expected to lobby hard to cut these last old-growth trees because of the huge amount of dense wood they contain.

North America™s Forests: Page 16

Although Canada's forests are far more extensive, with greater amounts of old-growth, they are being logged at an extremely rapid pace. The 1980s and early 1990s witnessed the clearcutting of millions of acres of Canadian forests, from boreal coniferous woodlands to deciduous and mixed forests in the east to the ancient temperate rainforests of British Columbia's coast. The logging that has removed vast tracts of Canada's forests is a major factor in the decline of the continent's colorful and ecologically important wood warblers and other songbirds. British Columbia's mountainous terrain is not conducive to clearcutting because of erosion, but this has been the method used to raze hundreds of thousands of acres. Wilderness valleys with forested slopes have been denuded and the soil and debris washed into salmon streams and rivers, clogging and destroying them. The Bowron Valley in central British Columbia was turned into a moonscape in 1992 when 1,600 square kilometers were clearcut; efforts to replant this huge area have not been successful (Devall 1993). Habitat of the Grizzly Bear in British Columbia's high-altitude forests has been devastated along with its forest wilderness home elsewhere in Canada (Devall 1993).

Research on Sitka Spruce (*Picea sutchensis*) canopies on Vancouver Island, along the British Columbia coast, has produced 300 new species of insects, and scientists state that this environment will reveal hundreds more. According to one biologist, "We have a virtually unexplored biological frontier in our own backyard" (Moffett 1997). A highly unusual Sitka Spruce, called "Golden Spruce" (*P.s. aurea*), grows on Graham Island in the Queen Charlotte Islands to the north of Vancouver Island (DePalma 1997). This extremely rare color phase had only one known adult specimen in the wild, the result of a genetic quirk that causes chlorophyll to break down, giving the needles a golden yellow hue when exposed to sunlight (Comeau 1997). Standing 160 feet tall, and 300 years old, the Golden Spruce was known to the native Haida tribe, who revered it, as "kiidk'yaas," or ancient tree (DePalma 1997). (A color photograph of this dazzling tree was published in the *Canadian Geographic* magazine in May/June 1997.) The Haida believed that the tree would be admired until their last generation and that it held the spirit of a young Haida boy who survived, along with his grandfather, the demise of their village, which was destroyed by an angry Creator (Comeau 1997). As they walked away, the elder warned the boy not to look back, but the boy disobeyed and was turned into a tree that came to be venerated as the embodiment of the tribe's spirit (Comeau 1997).

In January 1997, a mentally unbalanced man swam across the sound to the island and cut the tree down. This caused shock and dismay among the Haida, who felt they had failed in protecting this most important part of their traditions and believed that its death predicted their own demise (Comeau 1997). Fortunately, a few cuttings had been

taken from this tree in 1986 by a horticulturist, who brought them to the Botanical Garden at the University of British Columbia and propagated them. Two 5-feet-tall, scrawny trees were produced, and they are all that remain of the magnificent Golden Spruce (DePalma 1997). The Haida took about 100 cuttings from the top of the felled tree and asked the scientific community to help save it. They accepted one of the two propagated specimens from the university (Comeau 1997).

Vancouver Island, just north of Washington state, is one of the most magnificent scenic areas in the world. The struggle to stop clearcutting of its ancient forests has become pitched. One highly endangered species resident on this island is the endemic Vancouver Island Marmot (*Marmota vancouverensis*), one of 11 species of marmots in the world, all native to the Northern Hemisphere (Nowak 1999). Much of the Vancouver Island Marmot's habitat has been destroyed by development for ski slopes and logging, which apparently removed important migration corridors between colonies. This exposed the marmots to predation and prevented the establishment of new colonies (Thornback and Jenkins 1982). Colony sites became isolated, and vacant areas were not reoccupied, causing inbreeding (Thornback and Jenkins 1982). The Federation of British Columbian Naturalists formed a Vancouver Island Marmot Preservation Committee to conduct surveys and publicize the need to protect the Vancouver Island Marmot (Thornback and Jenkins 1982), yet in spite of long-term studies, logging continued. Surveys in 1979 and 1980 found only 11 colonies with 50 to 100 individuals (Thornback and Jenkins 1982). A 1984 survey found 231 animals, and some captive breeding has been successful (Nowak 1999).

The *2000 IUCN Red List Species* lists the Vancouver Island Marmot as Endangered (Hilton-Taylor 2000). It is also listed as Endangered by the US Endangered Species Act, and as Critically Endangered by the British Columbia Conservation Data Center of the province's Ministry of Environment. The Vancouver Island Marmot has been ranked in the most endangered category by the Center, as having few remaining individuals, and since this remnant population is continuing to decline, its extinction has become likely. By 1995, 11 colonies had declined to only eight, and the 1984 population of 231 animals had declined to only 150 animals. Biologist Andrew Bryant, chief scientist of the Marmot Recovery Foundation, conducted his Master's Thesis on the species and has continued to monitor it, according to the British Columbia Conservation Data Center. The population declined to a critical level in the late 1990s, and there are plans to take more animals into captivity to attempt captive breeding for future releases into protected habitat. In 1999, researchers found only 62 marmots left in the wild (NGS 2000). They took 27 into captivity for breeding programs. Bryant stated that the major threat to these animals was clearcutting, which greatly reduced their food supply; they are also vulnerable to predators (NGS 2000). The long-term plan is to reestablish these marmots in three separate sites and build populations up to 400-600 animals (NGS 200).

Vancouver Island's panoramic beauty is displayed in the 1994 film, fiRainforest of the Pacific Northwestfl (see Video, North America section). Aerial views of undisturbed forest and the majestic Clayoquot Sound contrast with large stretches of clearcut forest. Trees up to 270 feet tall and more than 1,000 years old grow on Vancouver Island, but less than one-third of the old-growth forest remains; at the making of the film only 4.5 percent of the forest was protected. The British Columbian government appointed a panel to recommend revisions to the logging plan for Clayoquot Sound and, to the delight of conservationists, issued recommendations in 1995 banning clearcutting and proposing strong streamside protections and so many safeguards that very little logging will be allowed (SCLDF 1995). In 1995, the British Columbian government announced that it would adopt all the recommendations made by the blue ribbon Science Panel. All commercial logging in pristine areas has been deferred until biological inventories are completed, according to the Rainforest Action Network (RAN). This does not mean a permanent end to logging in this beautiful Sound, and conservationists will need to continue the fight. The native-run Clayoquot Sound First Nations leaders are apprehensive that they may be pressured into joint logging ventures with timber companies, and they issued an unequivocal declaration calling for an end to commercial logging in all old-growth forests (Rosmarin 1995).

Forty miles north of Vancouver, old-growth coastal forests are being destroyed by commercial loggers to make way for urban and suburban growth. The Squamish River cuts through these forests and provides one of the great wildlife spectacles in North America. When salmon disappeared from almost every river of the Northwest and

pollution killed off fish in many northern states, Bald Eagles migrated north to the Squamish River (Nickerson 1995). Almost 4,000 Bald Eagles from as far away as Wisconsin and the Rocky Mountains winter along the river, feeding on spawning salmon (Nickerson 1995). "Americans are strange," a Squamish Native American remarked, "They revere the eagle as the pride of their country, then ruin his home and make him so hungry he flees to Canada" (Nickerson 1995). Yet this sanctuary is now threatened. A 600-acre industrial park at the heart of the winter roosting grounds is planned by local officials, and logging has removed much of the forest already (Nickerson 1995). The Nature Conservancy began acquiring parcels of land for the establishment of Canada's first sanctuary for Bald Eagles (Nickerson 1995). The goal of conservationists is a preserve of 2,700 acres to protect this important feeding area (Nickerson 1995).

North America™s Forests: Page 17

The white bears of Canada live along 1,000 square miles of rainforest on the British Columbian coast and off islands. Their main breeding island, Princess Royal Island, harbors the largest number of these bears, which are a rare color phase of the Black Bear. The percentage is even lower on other islands (Russell 1994). The world population of these bears is estimated at only about 400 (NRDC 2001). A delightful book, *Spirit Bear. Encounters with the White Bear of the Western Rainforest*, by naturalist Charles Russell, recounted his visits to the island with two filmmakers, Jeff and Sue Turner, who were working on "Island of the Ghost Bear." Russell, who has been studying and helping bears of many species throughout his life, wanted to write a book about the spirit bear to obtain sanctuary status for this island and its bears. The white bears on the island have been protected for thousands of years, first by the Native Americans, and now by the British Columbian government. They are so tame that Russell was amazed, having never encountered such friendly bears of any species. A young white bear came to inspect Russell and the filmmakers soon after they arrived, peering into their camera lens, leaving nose prints on the lens (Russell 1994). This bear would sit down near them, sometimes seeking their protection when larger Black Bears tried to take away salmon he had caught (Russell 1994). On one occasion, Russell followed the bear back into the forest to see where he went. After a long walk through the rainforest, the bear found a soft area covered in bright green moss and decided to take a nap. He was so trusting that he went to sleep with Russell watching him only a few feet away. While asleep, the bear seemed to be dreaming, his eyes moving, legs twitching, and sometimes grunting (Russell 1994). Russell's book is illustrated with many photos of the bear fishing, sprawled on his back in the forest, and climbing about the rocks. This bear let himself be scratched with a stick and even tried to wrestle with Russell and Jeff Turner. Russell and the Turners left the island but returned after a year, and the bear came to greet them, sitting down a few feet away as if they had not been gone at all (Russell 1994).

The entire range of this bear is slated for logging. The Black Bears living on these islands, which carry white bear genes and are only a bit less tame than the white bears, are hunted under British Columbian law, which allows two bears per hunter each season. When they were filming the bears, some Swiss, German and Austrian hunters had arranged a bear hunt (Russell 2000).

The film, fiGhost Bear,fl shown on PBS's Nature series in 1994, captured an island little changed for 10,000 years, never logged and teeming with wildlife. Black wolves, mergansers, Beavers, salmon and Bald Eagles live in this mossy, verdant forest with towering trees. The filmmakers urged protection for the bears and the forest. Other defenders of this bear and its forest are the members of the Kitasoo and Gitga™at Indian tribes of British Columbia, who believe that the white bears were created by a raven who came from heaven and decreed, "The white bears will live here forever in peace." The tribe wants to create a park of the entire area to protect the bears and the rainforest. Logging proceeded, however, within the proposed park, and a logging company cut a road through one island's ancient rainforest and the ancestral Kitasoo deer-hunting grounds. The Rainforest Action Network (RAN) began in the mid-1990s to help create a sanctuary, which is opposed by the British Columbian government. Twenty million acres of rainforest in the province may be cut, and RAN is campaigning to convince US customers to cancel contracts

and refuse to buy products from these ancient forests (Rosmarin 1995).

A Canadian couple, Ian and Karen McAllister, have formed an organization, Rainforest Conservation Society, to preserve the habitat of the Ghost Bears and the Great Bear Rainforest. Their book, *The Great Bear Rainforest, Canada's Forgotten Coast*, published in 1997 by Sierra Club Press, eloquently describes this magnificent region and their work to help preserve it. The Natural Resources Defense Council (NRDC), headquartered in New York, took on the cause in 2000, urging a consumer and commercial boycott of International Forest Products (Interfor), a logging company that is cutting the old-growth forests in the heart of 18 untouched rainforest valleys in the Great Bear Rainforest. As the company was about to clearcut East Creek on one island, it was stopped by construction of a tribal longhouse by the Gita™at Tribe at the mouth of the creek, aided by NRDC, which forced the company to suspend its plans (NRDC 2001). Negotiations between conservation groups and six logging companies, including Interfor, had appeared to achieve protection of the Great Bear Rainforest, but Interfor pulled out of the agreement and recently began logging within the habitat of the white bears. This devastation of a magnificent environment does not even make economic sense, as there could be a sizeable market for videocam views linked to a satellite of these enchanting bears and their mossy, green forests, paid for by viewers around the world for a long-term profit far exceeding that which will accrue to the loggers. The Giant Panda is also a charismatic species, and conservation donations from zoos now total $10 million a year or more to preserve the species™ habitat. The white and black bears of this wilderness deserve no less.

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Further inland, the Wood Buffalo National Park, bordering Alberta and the Northwest Territories, is the sole breeding ground of the endangered Whooping Crane (*Grus canadensis*). This enormous park, designated a United Nations World Heritage site, was logged in large clearcuts from the end of World War II until 1992, a tragic loss of old-growth boreal forest (Devall 1993). The logging was stopped by a lawsuit brought by the Sierra Club Legal Defense Fund (now Earthjustice Legal Defense Fund) in conjunction with the Canadian Parks and The Wilderness Society. The suit was based on the Canadian National Parks Act, which states, "The National Parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations" (Devall 1993). The Peace River, flowing through Wood Buffalo, is so contaminated by dioxin from the Daihowa pulp mill upstream that natives no longer eat the fish, their major food staple, from the river (Devall 1993).

By the end of 1988, one-third of the land surface of Alberta, Canada-- 221,000 square kilometers--had been logged. Much of Saskatchewan's former forested land--more than one million hectares--has been clearcut and not replanted, nor has it regenerated naturally (Devall 1993). Manitoba, south of Hudson Bay, protects less than 2 percent of its territory from development and logging. In 1989, the Manitoba government opened up an area the size of Ohio, 108,000 square kilometers, to logging (Devall 1993). Logging in Manitoba, Saskatchewan and Alberta fueled $10 billion in new pulp mills, major water and air pollution sources (Devall 1993).

Eurasian Temperate Forests

The Siberian Tiger's Domain
Land of the Giant Panda
Lost Forests of the Mediterranean and Europe

Eurasian Temperate Forests: The Siberian Tiger's Domain

Russia's coniferous forests form the major part of the Eurasian taiga, a mixture of spruce, birch and other evergreens, covering 3 million square miles, two•thirds of the country's land surface (Sparks 1992). It is the world's largest forest of any type, more than twice the size of the Amazon rainforest (Stewart 1992). Russia's taiga makes up half of the world's total area of coniferous forest and about one-quarter of the entire forested area of the world; the Siberian portion alone is one•third larger than the whole of the United States (Sparks 1992). The forested land east of the Ural Mountains covers 5 million square miles (Linden 1995). Further south, deciduous trees mix with aspen, birch and alder (Sparks 1992). This entire, vast forest may once have been the domain of the Siberian Tiger (*Panthera tigris altaica*), as its fossilized bones have been found on Lyakhov Island off the north coast of Siberia (Matthiessen 2000).

The vast expanses of taiga forests were opened up to international logging after the dissolution of the USSRF. By the early 1990s, about 304 million acres, two•and•one•half times the size of France, had been clearcut (Stewart 1992). Each year an additional 12 million acres are logged (Lean and Hinrichsen 1992). Commercial exports of Siberia's logs to the United States have been encouraged by various corporations and the US Department of Commerce. Logging has also been intense in Russia's Far East, an area of great biological diversity, with many resident endangered species.

A nearly pristine and stunningly beautiful part of Russia is the Kamchatka Peninsula in the Far East, jutting into the Pacific Ocean. This area has 29 active volcanoes, wild rivers, hot springs, and beautiful forests. An endemic tree, the Kamchatka Fir (*Abies gracilis*), grows only on this peninsula. A relict of pre-Ice Age coniferous forests, it is a silvery fir with soft needles, which grows to about 70 feet in height; this once widespread tree is now restricted in range (Sparks 1992). The forests of Kamchatka are being heavily logged (Meulenaer and Vaisman 1996). Another threat is gold mining, as $10 billion worth of gold is thought to lie under the forests and lakes of the Peninsula (Specter 1997).

The Kamchatka Sable (*Martes zibellina*) is larger than sables in other parts of Russia and was nearly trapped to extinction in the 19th century (Stewart 1992). The Sable's habitat is dominated by Stone Birch (*Betula ermani*) forests with thick, grassy undergrowth covering the mountain slopes; some of these trees grow to be 600 years old (Stewart 1992). Mountain Ash provide berries which, along with an occasional fish, supplement the Sable's diet of voles (Stewart 1992). Unfortunately, anti-trapping restrictions are not being enforced in Russia's Far East, even in nature reserves. The Kronotsky Nature Reserve, covering 3,860 square miles on the peninsula's east coast, shelters 700 species of tundra, taiga and mountain plants, with a number of unusual endemic plants, including the beautiful Kamchatka Rhododendron (*Rhododendron kamchatkensis*), which has miniature red blooms (Sparks 1992).

The magnificent Siberian or Amur Tiger is the largest of all wild cats. Only a few hundred years ago, its realm extended from northern Manchuria west to Lake Baikal and south to North Korea and northeastern China (Matthiessen 2000). Its range shrank over the centuries as a result of hunting, persecution, loss of prey species and habitat. Today it is restricted to the extreme southeastern Maritime Region in the Amur River basin east of Manchuria, west of Sakhalin Island (Miquelle *et al.* 1999). During the 1980s, the Soviet government established a series of reserves for the Tiger, but heavy logging and hunting in the region caused declines in its major prey species, boar and deer. Only 5 percent of the Siberian Tiger's habitat is protected in reserves, according to Evgeny Smirnov, a Russian biologist who studies Tigers (Gourevitch 1995). Moreover, a trade in Tiger bones and other body parts for Traditional Medicine has resulted in the killing, often brutal, of thousands of Tigers throughout their range from India east and south to Indonesia (see Trade chapter).

Siberian Tigers require very large territories. In Sikhote-Alin, their major protected reserve, there are only 10 to 15

resident adults on 400,000 hectares (988,400 acres) (Smirnov and Miquelle 1999). Such large home ranges make them extremely vulnerable to habitat loss, especially the fragmentation of forests by logging. This region™s volcanic peaks rise 5,000 feet from the sea, and forests are crisscrossed by rivers and dotted by lakes. Northern and southern forests meet here, harboring a myriad of tree species. Tall Korean Pines (*Pinus koreansis*) mingle with oaks, maples, walnuts and birches, and unlike the typical Siberian taiga, shrubs and undergrowth are luxuriant (Stewart 1992). These trees reach heights of nearly 150 feet and produce a great volume of cones, providing food for Wild Boar, Brown Bear, Manchurian Moose, and the endemic Ussurian Asiatic Black Bear (*Selenarctos thibetanus ussuricus*). Korean Pines have been so heavily logged outside the reserve that the species is now threatened; although it is protected, illegal logging still occurs (Bohan *et al.* 1996).

A highly unusual type of dark•barked, slow•growing birch grows here. Known as the "Iron Birch" (*Betula schmidtii*), its wood is reputedly so heavy that it sinks in water (Stewart 1992). The Primoryi Province, in which this preserve is located, harbors more than 150 species of trees and shrubs. The meeting of northern and southern forests in this region has resulted in a rich diversity of wildlife. The Ussuri Sika deer (*Cervus nippon hortulorum*) lives alongside the endangered Goral (*Naemorhaedus goral*), a goat•like ungulate native to mountains west to the Himalayas. This is the northern edge of the Leopard's range. The Amur Leopard (*Panthera pardus orientalis*) is a highly endangered subspecies, threatened by both habitat loss and poaching. Lynx and Common Otter are also native. The Dhole (*Cuon alpinus*), a threatened wild dog native to more southerly regions west to India, may also be native to the Sikhote•Alin Preserve. This extraordinarily rich diversity of predators and prey is at great risk from overhunting and logging, however.

As many as 340 species of birds have been recorded in Sikhote•Alin (Stewart 1992), including two endangered waterbirds, the Red-crowned Crane (*Grus japonensis*) and the Oriental White Stork (*Ciconia boyciana*) (Collar *et al.* 1994). A species of ginseng (*Panax ginseng*) grows in the undergrowth and is valued by the indigenous Udege people and others as an invigorating tonic, making it the "root of life" in their folklore. They believe that the ginseng is guarded by the great Siberian Tiger, and shrines are erected to the Tiger, who is believed to possess near•magical powers (Stewart 1992).

In 1991, the Hyundai Corporation of South Korea signed a 30•year contract to cut 500,000 acres of virgin forest on the Pacific slope of the Sikhote•Alin range (Schafer and Hill 1993). By the end of 1992, the area had been clearcut, and Hyundai began logging in the Bikin River Basin, the last pristine river valley in the region (Schafer and Hill 1993). In the Bikin, a small population of Udege live along the river's forested banks, as they have for hundreds of years, subsisting on local wildlife (Schafer and Hill 1993). These people have opposed the entry of the loggers, filing suit to stop the logging, threatening to shoot at logging trucks and removing markers from trees slated for cutting (Schafer and Hill 1993). Their protests succeeded in stopping the logging, negating the original agreement; Hyundai continues, however, to try to gain access to the Bikin forests (Bohan *et al.* 1996). This 600,000-acre watershed of the Bikin River is among the last virgin forests in Ussuria (Matthiessen 2000). A plan by the US Weyerhauser Corporation to cut an area of virgin forests the size of Delaware was thwarted by conservationists, and this forest has been declared a nature preserve (Nunn 1996).

Some 10 million acres of Tiger habitat are being clearcut every year, and members of the Siberian Tiger Project, composed of US and Russian biologists, are proposing alternate methods of timber harvest for the region (Quigley and Hornocker 1994). The native deer and boar, upon which the Tiger depends, are being hunted out of many areas by local villagers and professional poachers, who sell their bones and antlers for the Chinese Traditional Medicine trade. In 1995, the Russian government issued a decree "On Saving the Amur Tiger," which called for a specific plan and schedule to implement Tiger protection efforts (Galster 1996). In response, the Russian-American scientific team formulated a plan the same year to protect all existing Tiger habitat with connected reserves, new national parks, multiple use zones and ecological corridors linking them. It would be the world's largest sanctuary, preserving old-growth Korean Pine and designating various zones in this immense area, which extends from north of Khabarovsk south to Vladivostok in a mosaic of connected land (Galster 1996). The plan also called for a new national Tiger census, which was carried out in early 1996 and found more Tigers than previously assumed, an estimated 330 to 371

animals. The proposed protection plan, when combined with the Bikin traditional reserve and a large region a US government agency is helping to protect through multiple use, would preserve about 26 percent of existing habitat of the 156,000 square kilometers used by Siberian Tigers in Russia (Miquelle *et al.* 1999). The remaining area is either scheduled for logging or agricultural development. The Tiger biologists are urging that all Tiger habitat be included in a national protection plan, as signs of Tigers have been seen in 90 percent of the habitat (Miquelle *et al.* 1999). Coexistence between Tigers and people is essential. This would mean easing human hunting pressure on its prey, primarily Elk and Wild Boar, which have become rare, a major cause for the Tiger™s need of such large territories. Moreover, Tiger poaching needs to be stopped, and Tigers need access to river valleys, which they use for hunting and movements. Most of these have been taken over for human use.

The Siberian Tiger Project was the subject of a 1995 National Geographic film, "Tigers of the Snow," which included the first filming of a baby Siberian Tiger being weighed and examined by biologists in its wild den. The magnificent scenery of this coastal region was filmed from an aircraft, and areas of clearcutting were in stark contrast to the unbroken forests. The film also noted the sad end to a young Tiger hit by a logging truck. These trucks, loaded with giant tree trunks, thunder through the beautiful valleys. The Siberian Tiger Project is the first research study involving radio-tracking ever undertaken of the Siberian Tiger, and it is revealing new information on its range, behavior and habitat needs. Should the reserves be set aside, Siberian Tigers will be the first race or population of Tigers to become stabilized and perhaps increase at a time when all other populations are in drastic decline.

An eloquent book by Peter Matthiessen (2000), *Tigers in the Snow*, focuses on this research and the future of all Tigers. Anti-poaching work is helping to stem the decline of both the Tiger and its prey, but until its habitat is secure, this once proud cat, master of its domain, will remain beleaguered and under constant threat. Its world has become a battleground, filled with the screeching of power saws destroying the forests it needs to survive, and the constant threat of poachers. As a keystone species at the top of its food chain, the survival of the Tiger is "the best indicator of the health of the ecosystem as a whole" (Matthiessen 2000). Without the Tiger, the deer and boar will become slow, small and overpopulated, destroying their habitat as they have in Europe, where most predators have been eliminated. This is a crucial turning point for the species, whose tropical populations may not survive long. The Siberian Tiger inhabits a world without high human populations, a still-extensive forest habitat, and is the subject of a strong conservation program. The many people who are dedicated to saving it may succeed. In the words of Maurice Hornocker, an overseer of this research project, "One day it will be culturally unacceptable to kill Tigers anywhere for any reason" (Matthiessen 2000).

Eurasian Temperate Forests: Land of the Giant Panda

China's once extensive forests have declined over the centuries as human population increased. In south-central China, temperate forests of many types are watered by the five great rivers of Southeast Asia: the Mekong, Irrawaddy, Yellow, Yangtze and Salween (Mittermeier 1999). This is botanically the richest temperate region in the world, twice the size of California with half of China's plants--12,000 species, of which 3,500 are endemic (Mittermeier 1999). This is the home of the Giant Panda (*Ailuropoda melanoleuca*). Fewer than 1,000 of these black-and-white bears remain in small, scattered populations. When climates were cooler during the Ice Ages 12,000 years ago, Giant Pandas had a far larger distribution, covering much of central and southern China and bordering areas of Burma. As climates warmed and human populations took over much of their habitat, they declined in numbers, and their bamboo forests retreated. Today, Giant Pandas remain only in three provinces, with the largest number in Sichuan. Between 1974 and 1989, their habitat was halved as a result of logging and settlements, from 20,000 square kilometers to 10,000 square kilometers (Mittermeier *et al.* 1999). Satellite studies of their major reserve, Wolong Nature Reserve, found a dramatic decline in forest cover from 1965 to 1997 as growing numbers of people living in the reserve cut deciduous trees and bamboo for firewood (Revkin 2001). During the last decades, with international attention focused on this extremely charismatic animal, reserves have been set aside. Twenty reserves have been established in the

remnants of the Giant Panda's habitat, but the species has continued to decline as destruction of forests turn the reserves into islands surrounded by clearcut hillsides. Many Pandas have starved to death when their bamboo forests were cut or underwent a cyclical die-off. Prior to this deforestation, when local bamboo forests died off, Giant Pandas were able to wander widely in search of other bamboo. Their habitat has decreased so much that they are now at the mercy of local conditions within each reserve (Mittermeier 1999 *et al.* 1999).

A long•term study of this species by Dr. George Schaller, of the New York-based Wildlife Conservation Society, arrived at the pessimistic conclusion that the Giant Panda was headed inexorably toward extinction (Schaller 1993). In his 1993 book, *The Last Panda*, Schaller wrote a scathing and unflinching analysis of the failure of existing conservation programs. Among his conclusions was that almost all of the millions of dollars raised around the world to preserve this most popular of all animals had been wasted while wild Giant Panda populations dwindled. His research revealed that Pandas were readily taken into captivity during bamboo die•offs when, in fact, enough bamboo still remained to supply their needs (Schaller 1993). Most of the funds were spent on building dungeon-like breeding and holding compounds rather than on saving its ever•dwindling habitat or hiring wardens to prevent poaching (Schaller 1993). The Wolong Reserve, which covers 780 square miles, was the location of his research area. Wolong had 4,200 people living within its borders in 1989, who were cutting trees and setting snares to kill wildlife for meat, musk and skins (Schaller 1993). In eight years alone, 14 square miles of the Wolong forest were destroyed, and an unknown number of Pandas died in cruel wire snares (Schaller 1993).

Only time will tell whether the urgent habitat and anti•poaching needs of the Giant Panda will be met, or whether funds meant for its conservation will continue to be spent on breeding compounds. Seventeen forest corridors are planned to link fragmented habitat, but breeding and holding compounds continue to be built, with a goal of 32 stations (Williams 1994). A dedicated Chinese scientist, Pan Wenshi, who has studied these animals for decades, helped save the habitat of some 80 Pandas in these mountains when the high•pitched whining of chain saws was within earshot (Wenshi 1995). The National Geographic Society filmed the mother Panda that Pan Wenshi had studied throughout her life, Jiao Jiao, and her tiny mouse•sized cub when only a few days old (see Video section). This cub, a female he named Xi Wang, meaning Hope, grew into a healthy young Panda and, when four months old, took her first shaky steps out of the warm den (Wenshi 1995). As she grew older, Xi Wang took naps lying on her back in the tops of pine trees, watching her mother as she fed in the forest (Wenshi 1995).

If forest corridors are not soon set aside linking the reserves to one another to allow free movement of Pandas, the species will probably fade gradually to extinction from inbreeding (Lean and Hinrichsen 1992). One source of funding to preserve habitat is the Chinese government loan program, under which Giant Pandas are sent to foreign zoos for periods of up to 10 years. Various zoos in the United States have arranged such loans, paying the Chinese government $1 million per year per zoo, and these funds must be applied to conserving the species in the wild under supervision of the US Fish and Wildlife Service. A pair in the San Diego Zoo produced a healthy female cub in 1999 through artificial insemination. Other pairs were acquired by Zoo Atlanta and the National Zoo in Washington, DC, in 2000. Few Giant Pandas breed naturally in zoos. This funding and the new attention directed at conserving these highly endangered and endearing animals may turn the tide in China to protecting their habitat. If successful, it will also spell survival for thousands of rare Chinese plants and animals that inhabit the Pandas™ forests.

Xi Wang, the Giant Panda studied by Wenshi, inhabits the Qin Ling Mountains, haven for a wide diversity of rare plants. One mountain alone, the 12,359-foot Taibai Mountain, has 150 endemic species of plants, among them the Qin Ling Mountain Fir (*Abies chenensis*) (Ji 1990). Two varieties of this species are listed by the *1997 IUCN Red List Plants* (Walter and Gillett 1998). A neighboring mountain, the Shennongjia, is known as a "Treasure House of Plants" because of the many unusual and ancient species here (Ji 1990). In Hubei Province in the same region is the Dawn Redwood, a deciduous tree which is a close relative of the North American Coast Redwood and Sequoia but far more ancient in lineage (Ji 1990). Until 1941 when a few groves were discovered by Chinese botanists, the Dawn Redwood was known only from Jurassic fossils (MacKinnon 1996). Small populations survive in Sichuan, Hubei and Hunan provinces, but the species is considered Endangered by the International Union for the Conservation of Nature (IUCN) (Walter and Gillett 1998) and only about 1,000 trees may survive in the wild (Dyer 2000). This tree grows to

a height of about 115 feet, its delicate pinnate leaves turning golden in the fall. As the sole member of its genus, and a living example of trees that grew in the age of dinosaurs, it is considered a great botanical treasure.

Its seeds have been planted in many parks and botanical gardens around the world. John Williams, the award-winning composer, became fascinated with a Dawn Redwood growing in Boston's Public Garden (Dyer 2000). "It not only looked lovely, but it seemed animate, even intelligent," he said (Dyer 2000). By chance, he met a retired Harvard University botanist, Dr. Siu-Ying Hu, and praised the tree on a walk through the Public Garden. Hu pointed out that he had planted this very tree back in the 1940s, having brought a bag of seeds to America when he arrived from China (Dyer 2000). The Dawn Redwood inspired Williams to compose a musical piece entitled "Tree Song" for harps, keyboards, flutes and delicate percussion. It was performed by the Boston Symphony Orchestra at the opening of the summer concert series at Tanglewood, Massachusetts, in July 2000 and recorded on CD (Dyer 2000).

The extraordinary Dove Tree (*Davidia involucrata*) was named after its discoverer, Pere Armand David, a French missionary who traveled in China in the 19th century and named hundreds of animals and plants. Its white leaves are up to 6 inches long and 3 inches wide, resembling a flock of doves taking flight (Schaller 1993). These trees are quite rare in China, after centuries of deforestation (Walter and Gillett 1998). Even in 1900, when American botanist E.H. Wilson went to China to find seeds from this tree, he traveled six months before he even met someone who had ever seen one (Stocker 1997). When Wilson finally found a Dove Tree, only a stump remained: it had been cut and the wood used to build a house. He later found 10 wild specimens and brought back seed to Harvard University's Arnold Arboretum (Stocker 1997). This species, too, has ancient origins and once dominated prehistoric forests (MacKinnon 1996). Like the Dawn Redwood, it was rescued from extinction and is now cultivated in nurseries and botanical gardens (Stocker 1997).

Many of these plants and trees share the habitat of the Giant Panda, and forest reserves would ensure their survival. A number of endangered mammals that have disappeared from other regions as a result of hunting and habitat loss can be found in Wolong and other Giant Panda Reserves. The Red Panda (*Ailurus fulgens*), thought to be a relative of the Giant Panda, is a rare native, as are the Golden Monkey (*Pygathrix roxellanae*) and the Takin (*Budorcas taxicolor*), a goat•like ungulate. All three are endangered species and declining as the forests are cut. An endangered bird, the Sichuan Partridge (*Arborophila rufipectus*), is restricted to an area of less than 100 square kilometers in south-central Sichuan, where fewer than 2,000 birds survive (BI 2000, Collar *et al.* 1994). Its old-growth broadleaf forest is being felled at a rapid rate, and people enter its habitat to collect bamboo shoots in its breeding season, disturbances that are driving these birds toward extinction (BI 2000). Twenty-six other species of pheasants inhabit this part of south-central China, including the most iridescent birds in the world, the monals. The threatened Chinese Monal (*Lophophorus lhuysii*) inhabits rhododendron and high-altitude coniferous forests and is in decline as a result of logging and hunting, which have been facilitated by the construction of logging roads (BI 2000). The male Chinese Monal has dazzling plumage in an array of emerald green, purple, coppery-golden, purplish-green and white, while the female is more subdued in gray and rufous-brown. The creation of reserves for the Giant Panda have aided this bird's survival, as
several are within this bird's range (BI 2000).

China's 25,000 native plant species make up 11.4 percent of the world's plants, including many ancient ones (MacKinnon 1996). The Ginkgo (*Ginkgo biloba*) has been on Earth for 200 million years; this tree grows wild in scattered locations in China, indicating that it was once far more widespread and was eliminated by logging over the centuries (MacKinnon 1996). In prehistoric times, Ginkgoes grew throughout the world but were thought extinct until a few trees were found in remote forests (MacKinnon 1996). Its unusual wide, lobed leaves turn yellow in the fall before falling. This tree has been considered sacred by the Chinese for centuries and is grown in temple gardens and other religious sites. Extracts are sold around the world as an herbal stimulant. In the Himalayas, giant cypresses (*Cupressus*) grow to immense size when protected by Buddhist temples; one specimen measures almost 20 feet in diameter and is estimated to be 2,000 years old (MacKinnon 1996). Entire forests of these giant trees also grew on Taiwan, where only massive stumps remain (MacKinnon 1996). Stephen Spongberg, Curator at the Arnold Arboretum, has studied China's native trees and found numerous species to be extinct in the wild (Stocker 1997).

Antique Chinese furniture sought by collectors is often made from the wood of trees that are now extinct, and some trees are so rare that most Chinese botanists have never seen them in the wild (Stocker 1997).

China has more forest types than any country in the world. In the far north, taiga dominates. Conifers, birches and oaks blend into temperate coniferous forests in the northeast. Further south, the Giant Panda's habitat is temperate, evergreen forest. Himalayan forests occur in the west, and in the south, tropical monsoon rainforest prevails (Ji 1990). Unfortunately, very little virgin forests remain in the country, other than in high altitude and remote areas (Ji 1990). In the Giant Panda's highly diverse habitat of south-central China, less than 10 percent of the forests remain in pristine condition (Mittermeier *et al.* 1999). The destruction of these forests has been going on for centuries. During the 19th century, Pere Armand David lamented its destruction:

> *From one year's end to another, one hears the hatchet and the axe cutting the most beautiful trees. The destruction of these primitive forests, of which there are only fragments in all of China, progresses with unfortunate speed. They will never be replaced. With the great trees will disappear a multitude of shrubs and other plants which cannot survive except in their shade; also all the animals, small and large, which need the forest in order to live and perpetuate their species . . . They have the right to life and we annihilate them and brutally make existence impossible for them*
>
> Pere Armand David, 1875

In many parts of China, virtually no natural habitat remains, as centuries of human habitation and agriculture have replaced native vegetation and wildlife. One can travel for 1,500 miles in east•central China, for example, and see a landscape covered entirely with agricultural fields and villages, devoid of wildlife (Schaller 1993). Deforestation caused massive floods in the summer of 1995, when the Yangtze River, the country's longest, flowing from central China east to Shanghai, overflowed its banks. More than l.3 million people were displaced by the flooding, 900,000 houses collapsed, 2.7 million acres of crops were destroyed and 1,200 lives were lost (AP 1995). The economic losses were estimated at $4.4 billion. Each year these floods worsen as development covers the region, removing all natural flood controls (AP 1995). The last forests of any extent in China can be found in the northeast, and in 1987, fires destroyed 18 million acres (an area the size of Scotland) as well as 12 million acres in adjacent Russia (Schaller 1993).

Pere David's Deer (*Elaphurus davidianus*), named for its discoverer, and was once common in the northern forests and marshes. Hunting nearly eliminated the species, and to prevent its extinction, Chinese emperors kept the surviving population in a walled imperial hunting park near Beijing for more than 1,000 years. Even this population was killed by soldiers and villagers in the 1900 Boxer Rebellion, however; fortunately, some had been taken to England and kept by the Duke of Bedford on his estate (Schaller 1993). In 1985, 22 of these deer were returned from captive populations to the same walled park in China, now reduced from 150 square miles to 440 acres (Schaller 1993). Several other herds have been reintroduced elsewhere in China, numbering some 600 animals (MacKinnon 1996).

Reverence for nature in China dates back many thousands of years and is an integral part of the culture of this ancient country. It may now be reemerging. The 1979 Forest Law contained strict regulations on logging and required 40 percent forest cover in the mountains and 30 percent nationwide. This was strengthened in 1988 with a ban on logging in Yunnan and Sichuan, and legal protection was accorded to 389 plant and 206 animal species (Geatz 1999, Mittermeier *et al.* 1999). Reserves are being set aside throughout the country, increasing from 44 in 1956 to 600 in 1991, with a goal of 800 reserves protecting 5 percent of the country (Schaller 1993). This is indeed laudable in the most populous country on earth, and this eleventh-hour commitment is preserving many remnants of the once diverse and abundant natural heritage.

In practice, however, logging and firewood cutting tend to far exceed reforestation or preservation of forests in reserves or parks. Heavy livestock grazing by herders, who also clear forests for pasture, is devastating delicate forest

habitats (Mittermeier *et al.* 1999). Logging trucks carrying the trunks of the last remaining stands of old-growth forest can be seen in many areas. These deforested areas do not tend to regenerate because fires and grazing by goats kill the saplings (Mittermeier *et al.* 1999). During the late 1990s, The Nature Conservancy began a major project to study the biodiversity of the southern province of Yunnan, whose ecosystems range from alpine to subtropical forest (Geatz 1999). Certain tribes of this region have a strong tradition of conservation, and the provincial government has welcomed the help of this organization in helping to protect their natural heritage. Its 2000 report, "Conservation and Development Master Plan for Northwest Yunnan," includes recommendations for the protection of biodiversity, regional planning and resource development to provide ideas for non-destructive economic projects, such as growing plants for medicinal and ornamental purposes as an export commodity and developing ecotourism for this spectacular region (Geatz 1999, The Nature Conservancy 2000).

The future of China's forests and its tremendous biological diversity are greatly affected by its enormous human population of more than 1.2 billion people, whose growing needs encourage heavy hunting of its depleted deer and ungulate populations and large livestock herds, as well as excessive tree cutting for firewood (Mittermeier *et al.* 1999). Various international conservation organizations are working to help China in assessing its diversity and the threats to it, and to encourage enforcement of its 1982 Constitution, which states that the nation must protect and improve its environment and ecosystems, prevent pollution and protect precious animals and plants (Mittermeier *et al.* 1999).

Asia's beautiful pheasants and partridges are disappearing rapidly as their forests are cut and many are hunted for meat. Partridges and pheasants are found from the Himalayas to sea level tropical forests throughout most of Asia. They have declined dramatically, however. Of 22 species of Asian partridges, 15 species, or 68 percent, are listed by BirdLife International in *Birds to Watch 2: The World List of Threatened Birds* (Collar *et al.* 1994). An even higher degree of threat is suffered by the many spectacular pheasants. Of the 52 species of Asian pheasants, 38 species, or 73 percent, are threatened by the destruction of forests and hunting by the same authorities (Collar *et al.* 1994). Some endangered Himalayan pheasants include the Tibetan Eared Pheasant (*Crossoptilon harmani*), White Eared-pheasant (*Crossoptilon crossoptilon*), Cheer Pheasant (*Catreus wallichi*) and Elliot's Pheasant (*Syrmaticus ellioti*) (Collar *et al.* 1994). They show a great variety in their colorful and iridescent plumages, rivaling birds-of-paradise in beauty. Their relatively large size and brilliant plumage make them vulnerable to hunters, and they have not been studied intensively in the wild to determine habitat size and other requirements for their survival. Very few species have been protected in parks and reserves.

The mixed hardwood forests that once cloaked the Himalayas, studded in many areas by native rhododendrons, have been decimated during this century. Some 57 Asian rhododendrons are listed by the *1997 IUCN Red List Plants*. The deforested steep slopes are now prone to erosion by the monsoon rains that arrive annually. Heavy rains bring huge landslides and floods. Tree cutting, primarily by people gathering firewood or clearing land for agriculture, has been particularly severe in the Indian, Pakistani and Nepalese Himalayas. The once unbroken stands of oak and pine have become fragmented and totally absent in many areas. Human populations have risen over the past century to levels far above carrying capacity of this delicate region.

The Ganges River, which flooded only once every 50 years prior to deforestation, now floods every few years since the Himalayan forests that retained the water throughout the years have been logged (Lean and Hinrichsen 1992). Only Bhutan has preserved the majority of its forests, which are crucial to the survival of many species extinct elsewhere in the Himalayas. Tigers, Asian Black Bears, Himalayan Tahr (*Hemitragus hemlahicus*), Red Pandas, Golden Leaf Monkeys (*Trachypithecus geei*), and Tibetan Macaques (*Macaca thibetana*) are among the many mammals endangered by the loss of Himalayan forests. The Woolly Flying Squirrel (*Eupetaurus cinereus*), the largest squirrel species in the world, has just been rediscovered in northern Pakistan after being thought extinct for 70 years (Walters 1995). Four feet from its nose to the end of its tail, this squirrel may be able to glide distances of up to 1,000 feet (Walters 1995). Peter Zahler, a Cornell University zoologist, traveled to Pakistan in 1994. In a remote valley where this squirrel was rumored to exist, a local villager, who found one in a mountain cave, supplied a live animal in a bag. Zahler studied it for a short time, photographed and measured it, and then hiked 3 hours up the

mountain and released the squirrel at its capture site (Walters 1995). This squirrel has been designated Endangered by the *1996 IUCN Red List Animals*. This exciting rediscovery is tempered by the threats from deforestation and overgrazing in its mountain habitat. Local people report that it is solitary and active throughout the year, climbing conifer trees to feed (Nowak 1999). The Woolly Flying Squirrel is not hunted, but the conifers on which it depends are being cut at a great rate, causing it to decline over the past decade (Nowak 1999). Its total population is estimated at fewer than 2,500 and falling as a result of habitat loss (Nowak 1999). (Photos of this squirrel appear in Nowak 1999.)

Eurasian Temperate Forests: Lost Forests of the Mediterranean and Europe

Forests of towering cedars, oaks, firs, pine and beech once blanketed the region surrounding the Mediterranean Sea. Wildlife abounded in these primeval forests. Some 8,000 years ago, forest cutting began (Mittermeier *et al.* 1999a). Livestock gradually replaced wildlife, stripping the vegetation. In 3,000 B.C., Phoenicians logged the great forests of Cedars of Lebanon (*Cedrus libani*) for ship and building construction to trade with Egyptians and other cultures (Mittermeier *et al.* 1999). These massive trees reach 130 feet in height and are among the most majestic and stately of all trees. On the island of Cyprus, an endemic cedar, the Cyprian Cedar (*Cedrus brevifolia*), covered the island. Centuries of tree cutting and livestock overgrazing have reduced this tree to a relict population. Other forests on the Mediterranean's eastern shores were felled for building and to clear land for agriculture and grazing. The Greeks cut their forests in spite of warnings by the philosopher Plato as early as 4,000 B.C. that water supplies and wildlife would disappear (Pontiff 1991). The country's climate grew dryer and its topsoil washed into the sea (Runnels 1995).

Italy's southern forests were cut in Roman times, but north of the Adriatic Ocean, large expanses of beech and oak forests remained intact until the 16th century when they became the raw material for ships and galleys that sailed the Mediterranean waging battles and trading. Enormous amounts of lumber were needed to build these ships. When an exact replica of a galley was reconstructed a few years ago, 650 mature trees were required: 50 beech trees were needed for oars, 300 pines and firs for planks and spars, and 300 mature oaks for hull timbers (Attenborough 1987). In 1571, Venetian fleets battled the Turkish fleet which had been attacking and looting their ships. The 500 vessels in the Venetian and Turkish fleets had required the felling of more than a quarter-million mature trees (Attenborough 1987). Soon thereafter, the building of Venetian galleys came to an end for lack of trees, and shipbuilding moved elsewhere in Europe where trees were still abundant (Attenborough 1987). A single forest resembling the original beech and evergreen forest remains intact near the Adriatic in the former Yugoslavia. Its beauty was filmed for the series, fiThe First Eden. The Mediterranean World and Manfl (see Video section, Regional, Mediterranean).

Hardwood forests covered much of Spain until the early 16th century when, by royal decree, it was decided that the economy of the country could be expanded by developing a Spanish monopoly on the breeding of Merino sheep for their valuable wool (Attenborough 1987). Sheep herds became larger and larger, and forests were cut to provide grazing land. Within decades, the forests that had covered central Spain were gone, and topsoil had eroded, leaving shrubland (Attenborough 1987). These forests have not regenerated. Some oak forests have survived in parts of Spain, but intact ecosystems with native ungulates and predators have disappeared. Livestock grazes in all but the most remote areas. The few remaining Gray Wolves, as well as the endemic Iberian Lynx (*Felis pardina*), are critically endangered due to loss of forests and persecution. As an indication of the degradation of habitat, many species of Spanish wildlife are threatened with extinction. Worldwide, about 11 percent of the world's birds are threatened with extinction (Collar *et al.* 1994), but 37 percent of Spain's birds are threatened, 53 percent of its mammals, 41 percent of its reptiles, and 45 percent of its amphibians (Peters and Lovejoy 1990).

Forests of pine, cedars and oaks blanketed the slopes of the Atlas Mountains of Algeria and Morocco prior to the

Roman conquest. Logging by the Romans and people in the intervening centuries has destroyed all but fragments of these forests. The Atlas Bear (*Ursus arctos crowtheri*) originally ranged in these forests but was gradually pushed toward extinction by loss of its forest habitat, hunting and capture. The last of these bears was killed in the late 19th century (Day 1981). The endemic Atlas Cedar (*Cedrus atlantica*) has wide girths and grows to heights of more than 125 feet. They are often covered in moss and lichens in the cool altitudes (color photo, see Mittermeier *et al.* 1999a). Unfortunately, they are fast being depleted by timber cutters in Morocco and Algeria (Mittermeier *et al.* 1999a). North Africa's forests have become fragmented by centuries of logging and heavy grazing by cattle, sheep, and goats. The native Wild Boar (*Sus scrofa*) have also been extremely destructive to the few forests that remain, endangering many birds (Collar and Stuart 1985).

Surprisingly, a bird species native to the Atlas Mountain forests remained unknown until 1975. The Algerian Nuthatch (*Sitta ledanti*), a small, buffy songbird with white eyebrows, was discovered in a national park on Mont Babor (Collar and Stuart 1985). Even in national parks in this region, however, livestock are permitted to graze, consuming young trees and other vegetation. After conservationists protested that this little bird's entire habitat would be eliminated if livestock were not excluded, sheep and goats-- but not cattle--were banned from the park in 1981. To prevent forest cutting by the local people, propane gas has been supplied to use as fuel for cooking and heat (Collar and Stuart 1985). The forest on Mont Babor consists of mixed Atlas oak, Atlas Cedar and the Algerian Fir (*Abies numidica*), a threatened species which grows only on this mountain (Walter and Gillett 1998). The Algerian Nuthatch uses cedars, oaks and, especially, the Algerian Fir for seeds and nesting (Harrap and Quinn 1995). The population of about 80 pairs of Algerian Nuthatches censused in Mont Babor National Park in the early 1980s remained constant, and in 1989, a second population of about 350 birds was discovered in a nearby oak forest within the Taza National Park (Collar *et al.* 1994). Even though the Taza has National Park status, conservation of the forest has been hindered by cattle grazing that prevents tree regeneration. Also, wood-cutting is allowed that removes potential nest sites, and fires are set, killing many types of animals (Harrap and Quinn 1995). These birds also survive in two small isolated tracts of unprotected, degenerating forest 30 kilometers away, but the total population probably does not exceed 1,000 birds (BI 2000).

Another rare animal, the Barbary Deer (*Cervus elaphus barbarus*), barely clings to life in the disappearing Algerian forests. It is now extinct in Morocco and survives only in a small forest of cork oak and pine on the border between Tunisia and Algeria. They number only a few hundred, including a captive population, and are declining each year. This subspecies of the European Red Deer is listed as Endangered onthe US Endangered Species Act.

Israel has reintroduced related subspecies of some wildlife that have become extinct, bringing in closely related races of gazelles, wild goats, wild asses and Ostriches. The forests, however, are unlikely to return. The vegetation surrounding the Mediterranean today is dominated by shrubland that can regenerate after frequent burning (Mittermeier *et al.* 1999a). Livestock in vast numbers consume tree saplings and pull plants out by the roots. Goats are able to climb low bushes and graze their tops. The soil structure is very loose and alkaline, and the nutrients have been leached out by thousands of years of cultivation, overgrazing and erosion. Only plants that survive in arid climates on poor soil, such as succulents, annuals and those that regenerate from roots, can grow here (Peters and Lovejoy 1990). In many areas, exotic species, such as American prickly pears and Australian eucalyptus, have taken over as a result of the impoverished soil. The remaining bits of forest in southeastern Spain, Morocco, Algeria, Syria and Israel are being cut for fuel at a rate of 14 percent per year (Peters and Lovejoy 1990). The net result of the widespread loss of forests in the Mediterranean is that only about 1 to 2 percent of pristine, original forest remained at the end of the 20th century, all in small fragments surrounded by farmed and developed land (Mittermeier *et al.* 1999a).

The transitions that brought about the present state of affairs occurred over many centuries. So gradual was the environmental deterioration that one generation of people was usually unaware of the ecological changes wrought by previous generations. Once the forests were lost, succeeding generations may have been unaware that they had ever existed. Whether any progress can be made in regenerating forests by bringing in topsoil and replanting in protected areas will depend on the concerns and will of the people of the Mediterranean, who number more than 300 million

(Peters and Lovejoy 1990).

North of the Mediterranean, vast forests covering most of Western Europe remained until a few hundred years ago. Deciduous and mixed pine forests were logged over the centuries near towns and cites, and the forests retreated, replaced by agriculture and grazing land. By the 18th century, 90 percent of the forests had disappeared. In Scandinavia, Germany, Austria and Switzerland, tree farms have taken the place of natural forests. Man-made hallmarks of civilization now cover northern Europe except for a few isolated pockets of original virgin forest. Along with these forests, went the Auroch (*Bos primagenius*), an immense wild cow that became extinct in the 17th century. The large predators, Gray Wolves, Lynx and Brown Bears, that preyed on deer, elk and European Bison (*Bison bonasus*) were persecuted to near extinction and remain very rare. The largest remnant of these once vast forests is Bialowieza, on the Polish-Belarus border. It harbors the last herd of free-ranging European Bison and a small number of Gray Wolves.

An organization to protect these wolves, The Association for Nature "Wolf" is also concerned about the cutting of the old-growth trees in Bialowieza Primitive Forest, of which only 22 percent is protected in Poland (Nowak and Myslajek 1999). The "Wolf" organization is working to stop logging and protect this forest for future generations by the creation of a transnational park with Belarus (Nowak and Myslajek 1999). As the top predator in this and other forests of Poland and other European countries, the Grey Wolf helps maintain the health of the forest and cull overpopulations of hoofed animals such as deer. *Wolfnet*, the bulletin published by The Association for Nature "Wolf," is helping to educate the public about this maligned animal, which is often killed on sight in Europe. The organization is also sponsoring studies of the estimated 500 wolves in Poland and training livestock owners in the use of guard dogs to protect sheep (Nowak and Myslajek 1999).

Eurasia's northern boreal forests, or taiga, are far more extensive than North America's, stretching 6,000 miles from the Atlantic coast of Norway east to the Sea of Okhotsk on the Pacific rim (Sparks 1992). The western section in Scandinavia is almost gone: more than 90 percent of the taiga in the Scandinavian peninsula has been replaced by tree farms, which support almost no wildlife (Walsh 1995). Norway has lost 100 percent of its natural forests, and Sweden and Finland nearly all of theirs (Walsh 1995). The result of this destruction has been a crash in forest biodiversity and declines in many forest species. Seventy•three species of birds are declining or vulnerable in this region, including the Siberian Jay (*Perisoreus infaustus*) and White•backed Woodpecker (*Dendrocopos leucotos*) (Walsh 1995). Sweden's tree farms have replaced more than 200 species of plants and animals, and 800 species are rare or declining, as reported in *Taiga News: Newsletter on Boreal Forests* in 1992. The same publication noted that 805 species are endangered from clearcutting old-growth forests in Finland, and conservation groups have formed to try to save them from corporate logging. The Russian portion of taiga forest, which makes up the majority of these forests, has been less damaged, but with the fall of the Soviet Union, forests are now open to international lumber companies. Much of this forest is so remote that it may never be logged, but millions of acres are likely to be leveled over the next century.

Temperate Rainforests of the Southern Hemisphere

South of the Equator, in widely separated areas, are remnants of forests with species of trees older than the dinosaurs. These temperate rainforests grow in southern Chile and Argentina and, far to the west, in New Zealand, eastern Australia and the islands of Norfolk and New Caledonia. They have been growing nearly undisturbed for more than 100 million years, and many species of animals native to them have ancient lineages as well. Giant beeches grow in southern South America as well as far away in southern New Zealand and Australia. All these trees once grew on the southern supercontinent, Gondwana, some 160 million years ago. New Zealand, Australia and South America were joined and these trees were part of vast primitive forests. The continent gradually broke apart. Many species of trees survived on these new continents and islands as long as they could adapt to the new climates of the

different latitudes and longitudes, where they were pushed by continental drift through movements of the Earth's tectonic plates. In spite of eons of dramatic changes on Earth, geological and climatic, large fragments of these ancient forests have survived to the 21st century, only to face possible extinction. The wildlife now inhabiting them is predominated by more recently evolved species which coexist with species whose ancestors inhabited Gondwana. These fragile and unique ecosystems have undergone radical changes over the past few centuries, and many have been logged and cleared, with serious consequences for the native wild animals and plants.

South America

Only a century ago, South America's primitive forests blanketed the entire region from the southern tip of the continent north half the length of Chile's coast and eastward into Argentina's Patagonia. Beech trees of the genus *Nothofagus* covered most of the region, mixed with evergreen and various deciduous trees. Once extending more than 35 million acres, these forests comprised the largest stands of pristine temperate rainforest in the world (Nash 1994). *Nothofagus* beeches are among the most ancient species of trees and have been on Earth more than 150 million years. Soon after their arrival in the 16th century, European settlers began logging these forests, but not until the 20th century did widespread clearance begin. During the 1940s and 1950s, some 13,000 square miles, or 8.3 million acres, of these beech forests were cleared and burned for cattle ranching. Commercial logging continued, subsidized by the Chilean government, which spent comparatively little on forest conservation (Sims 1995). These beautiful forests have been cut mainly for wood chipping factories that produce paper pulp for export to Japan. Powerful commercial lobbyists have opposed legislation to protect the portions of these forests that remain, enabling logging companies to continue clearcutting, pushing some species to the brink of extinction. Once logged, the land is replanted with plantations of eucalyptus or pine, or turned into pastureland for livestock. The *1997 IUCN Red List Plants* lists four species of *Nothofagus* native to Chile and Argentina as vulnerable, indicating a decline toward Endangered status that, if not reversed, will result in their extinction (Walter and Gillett 1998).

Not all Chilean government officials are proponents of the logging. Carlos Ritter, head of the technical department for the National Forest Corporation, a government entity, complained: "Japan has fomented the cutting of our native forests, but they try not to assume responsibility. They say they are only buying the wood. But they have created so much demand the peasant farmer cannot resist cutting his forest" (Nash 1994). During the 1990s, an American logging firm, the Trillium Company, purchased 632,000 acres, or 987 square miles, of ancient forest in the southernmost region, Tierra del Fuego (Sims 1995). The Chilean government overruled opposition and gave permission to the company to begin logging in mid-1996.

An American conservationist, Douglas Tompkins, has preserved some of these forests. He purchased 741,000 acres in the southern province of Palena with more than $12 million from his clothing chain, Esprit. The cost of these beautiful forests, at $17 per acre, was miniscule in comparison to the cost of preserving temperate rainforests in the United States. Save•the•Redwoods League, an American conservation organization founded in 1918, recently celebrated its 75th anniversary, having spent $73 million to save 260,000 acres (about one•third of Tompkins™ acquisitions in Chile) of Coastal Redwoods at an average price of $280 per acre (National Geographic Society 1993). Most of the acreage of American old-growth redwoods that has been saved was purchased decades ago, and today it is worth hundreds of thousands of dollars per acre. The timber saved by the Save-the-Redwoods League is worth more than $5 billion (National Geographic Society 1993).

Tompkins' land includes South America's largest block of virgin temperate rainforest, protecting 78 percent of the remaining old-growth rainforest in Chile, including the country's largest remaining virgin stands of Chilean Larch or Alerce (*Fitzroya cuppressoides*) (Bowermaster 1995). This endemic and ancient tree grows to heights rivaling North American Coast Redwoods, with girths nearly as great as Sequoias (*Sequoia dendron*) (Dorst 1967, Walter and Gillett 1998). These majestic trees can live up to 4,000 years and take 500 years to reach commercial size. Extremely slow

to reproduce, Alerces do not produce seed until 200 years of age. Like redwoods, they are highly coveted for their lumber and have been cut with little regard to conservation. Highly endangered in Argentina and Chile (Walter and Gillett 1998), few groves of these trees remain, and although officially protected, they are sometimes illegally cut for the international timber market.

Tomkins came under attack by Chilean politicians and leaders of the Catholic Church who questioned his motives in purchasing such a large area and objected to his organization, the Foundation for Deep Ecology, for its statements about the importance of birth control to prevent human overpopulation (Sims 1995). Others falsely accused him of razing forests, setting up a nuclear dump, promoting abortion and even importing Israeli commandos. Many objected to private ownership of extensive areas of land by foreigners or disliked the idea of large-scale land preservation, but a Chilean conservation organization, the National Committee for the Defense of Fauna and Flora, rallied to his defense. After much contention, the Government of Chile accepted Tompkins' gift of 677,000 acres as a park in July 1997 (Grove 1999). It is known as Pumalin National Park and is considered one of the most ecologically important national parks in South America.

In an ominous note, part of the agreement with the Chilean government allowed access to the park by mining companies. The forest will not be logged, and there are plans for tourist accommodations and trails for hiking. This land is spectacularly beautiful, with glacial lakes and waterfalls, bisected by pristine rivers, its ancient forests teeming with wildlife. Covering the entire width of Chile, it borders a magnificent coastline with abundant marine mammals and sea birds. If preserved with care, the park will prevent the extinction of Chilean Larch and at least a portion of the magnificent southern beech forests which have been destroyed elsewhere. Ecotourism is being developed in the park area on a very small scale, with rustic accommodations, and tours from the United States and elsewhere are now visiting the park regularly. Not far to the north, the Parque Nacional Huerquehue preserves some of the magnificent scenery of this region. Known as the Lake District, portions of old-growth rainforest are protected in a landscape of crystalline lakes, waterfalls and churning rivers.

Another tree that survives from the Jurassic, the Monkey Puzzle Tree (*Araucaria imbricata*), has a somewhat larger range in South America. It is a member of a family of primitive conifers, the Araucaria, that grew on Gondwana. Monkey Puzzle Trees are being logged for timber and displaced by development, cattle ranches and mines. Named for their dense and interwoven crowns said to puzzle monkeys climbing them, the wide, unbranched trunk is covered in leathery bark in a knobby, diamond-shaped pattern. The nuts produced by these trees have been prized by the native Malpuche people for thousands of years. Malpuche means "People of the Monkey Puzzle Tree," and traditionally they did not overexploit these trees. Commercial exploitation of the nuts in local markets is threatening the species by leaving too few seeds for regeneration. Extracts from the Monkey Puzzle Trees have shown promise as a birth control drug, a traditional use by native peoples.

Like the Alerce, Monkey Puzzle Trees live to be very old, at least 1,300 years, and trees of the Araucaria family are considered the progenitor of all pines (Grove 1999). (See photographs in Grove 1999, and Dorst 1967.) When the Discovery Channel-BBC producers of the documentary film, fiWalking With Dinosaurs,fl searched for living landscapes in which to place their animated dinosaur models, an open forest of Araucaria trees in Chile was selected as an authentic backdrop, having changed little since dinosaurs fed on their crowns. The book based on this film has photographs of Araucaria forests from the movie (Haines 1999). Thirty-eight species of Araucaria survive, distributed in South America, New Zealand, Fiji, New Caledonia, Australia and Norfolk Island north to Malaysia. More than three-fourths of these, 30 species, are threatened with extinction, according to the *1997 IUCN Red List Plants* (Walter and Gillett 1998).

Another family of trees dating back to Gondwana, the podocarps, are also extremely primitive evergreens. Podocarps often have straight, unbranched trunks and clumps of dense needles near the trunk. Like the Araucaria, many of the species in the family are in decline: of 125 species worldwide, 70 are threatened (Walter and Gillett 1998). Two of these inhabit the southern rainforests of Chile and Argentina, and others survive in more tropical climates in Venezuela, Bolivia and Brazil, Madagascar, New Caledonia, Fiji, New Guinea and Malaysia. Australia

and New Zealand have more temperate climates and many native podocarps.

A threatened bird native to the old-growth forests of Chile and southern Argentina is the Slender-billed Parakeet (*Enicognathus leptorhynchus*), one of the few members of the parrot family that can survive cold climates. It has undergone steep declines in recent years as a result of forest clearance (Forshaw 1989). At least 22 bird species are restricted to Chilean *Nothofagus* forests, making this region a center of endemism (Cracraft 1985).

The most endangered denizen of southern rainforests may be the South Andean Huemul (*Hippocamelus bisulcus*), a short•legged, stocky deer that once lived throughout this habitat in Chile and Argentina. Driven from most of its haunts by the introduction of European deer, cattle ranching, logging and hunting, they now survive only in the extreme south of Chile, in tundra•like terrain with elfin woodlands. Low, gnarled trees are whipped by the strong ocean winds from Antarctic regions (Dorst 1967). No more than 1,300 South Andean Huemul are thought to remain (Nowak 1999), and a campaign has been launched to save these deer (Stutzin 1995). The National Committee for the Defense of Fauna and Flora and the Frankfurt Zoological Society are researching their status and raising money to purchase sufficient habitat for their survival (Stutzin 1995). Two reserves protect about 100 Huemul, but as the target of meat poachers throughout their range, they are found only in inaccessible areas. Researchers studying these deer, which had never had contact with humans, found them completely unafraid, grazing and bedding down within feet of their tents. This tameness makes them especially vulnerable to poachers.

Without immediate habitat protection and guarding of the remaining deer, the Huemul may not last long. Their status has declined even in national parks within the past few years. Alejandro Frid, a biologist who found these deer living in pristine habitat along a fjord in extreme southern Chile in a 1990 study, returned in 1995 to find near-disaster. Cattle had been set free in the Bernardo O'Higgins National Park, displacing the Huemul from their prime grassland habitat and forcing them into the sparse vegetation of the uplands (Frid 1997). He was told by a local ex-poacher that illegal hunting by local fishermen still occurred, and the lowland habitat was so trampled by the cattle that it was covered in muddy pits (Frid 1997). Ironically, the owners of the cattle did not eat beef but were adopting European cultural traditions, and since this harsh region did not provide good habitat, the cattle were not in good condition (Frid 1997). Conservationists are working to have the cattle removed from the national park, and international organizations are working to protect remnant populations of these deer. On the Straits of Magellan, where other South Andean Huemuls survive, commercial logging corporations are clearing forests (Frid 1997). The introduced Elk (*Cervus elaphus*) competes for habitat, and many Huemul are killed in attacks by domestic dogs (Nowak 1999). The South Andean Huemul and its close relative the North Andean Huemul (*Hippocamelus antisensis*) are both listed as Endangered on the US Endangered Species Act. This listing may not prevent their extinction, however.

The world's smallest deer, the Southern Pudu (*Pudu puda*), also inhabits southern temperate rainforests. This dog-sized deer is short-legged, with thick, buffy, reddish-brown fur and small, spike-like antlers. It is so diminutive, weighing only 5.8 to 13.4 kilos (Nowak 1999), that people have captured them as pets, which has contributed to their rarity. Its range within Chile was once far more extensive (Nowak 1999). The major threat to this species and its close relative, the Northern Pudu (*Pudu mephistophiles*) of the Andes of Peru through Colombia, is forest destruction. *Pudu puda* is listed as endangered on the US Endangered Species Act and on Appendix I of CITES, banning commercial trade, but hunting still threatens it.*

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*Many trees of the southern beech forest, the South Andean Huemul and Pudu deer appeared in the 1997 film, fiChile, Land of Extremesfl (see Video, Central and South America section); the trees were photographed in *Living Planet, Preserving Edens of the Earth* (Grove 1999).

New Zealand

New Zealand was formed some 80 million years ago when it broke off from the tropical southern continent, Gondwana (Molloy 1994). The land mass moved away with resident pterosaurs, sauropod and carnosaur dinosaurs, along with primitive frogs, lizards, land snails, spiders and other insects and invertebrates. It is also possible that the ancestors of the flightless moas and kiwis were present on Gondwana (Heather and Robertson 1997).

Unlike South America, New Zealand remained uninhabited by humans until a thousand years ago, allowing an extraordinary fauna and flora to evolve. Giant trees of many types, some almost as massive as sequoias and others rivaling American Coast Redwood in height, thrived in primeval rainforests and swamps. The dinosaurs died off 65 million years ago simultaneous with their extinction elsewhere in the world. Over the eons, as the land moved southward, the climate cooled. Many tropical species, unable to adapt, died out, while others coexisted with immigrant species of plants, birds and insects that arrived by wind or ocean current. Geological and climatic events--from earthquakes and mountain uplifts caused by movements in the Earth's plates, to the weathering of wind, sun and rain--produced great changes in the topography over the millennia. The original land mass split into two main islands and many satellite islands, and snow-capped mountains rose on the southern island. Ice Age glaciations occurred during the Pleistocene between 2.4 million years and 10,000 years ago (Molloy 1994). These cold periods did not, however, eliminate the majority of ancient plant or animal species, another proof of their amazing adaptability.

When the Polynesian Maori people arrived about 1,000 A.D., temperate rainforests with understories of giant tree ferns grew throughout the island's swamps, lowlands and highlands, over 80 percent of the land. The Maori must have been stunned to see thousands of flightless birds of various sizes roaming the island. The moas had evolved from a single ancestor into some 11 species which grazed in herds or in small groups. Following the extinctions of the dinosaurs, moas evolved in a wide range of species able to browse vegetation in forest, shrubland and grassland habitats (Molloy 1994). The native plants developed thorns and other means of defense against the moas. These plant adaptations persist today, long after the disappearance of the moas, remnants of a bizarre and fascinating ecosystem. These emu-like birds ranged from chicken-sized to a species 10 feet or more in height, the tallest bird that ever lived. With heads disproportionately small and necks long and gangly, these down-covered birds walked about on thick, scaly legs. Also resident on the islands was a massive eagle, weighing up to 29 pounds (Molloy 1994). This giant bird of prey was the largest eagle to have ever lived on Earth and may have preyed on moas or soared about in search of moa carrion.

On the southern island, penguins lived on rocky coasts and in wet coastal rainforests; one species was a giant, standing more than 5 feet tall (Molloy 1994). No mammals other than bats were native. Lizards called tuataras, older than dinosaurs, lived in many habitats on the islands. Primitive and unusual frogs of types long extinct elsewhere were abundant, especially in mossy rainforests. Huge, cricket-like wetas, insects virtually unchanged for 200 million years, had evolved into 70 species. Compared to grasshoppers, wetas have heavy bodies, weighing as much as 2.5 ounces. Scurrying about at night, their diet and behavior are rodent-like. They are considered by zoologists to be among the most interesting animals on the islands (Molloy 1994).

The forests were dominated by trees very little changed since the age of the dinosaurs. Three major groups of trees, all evergreens, dominated New Zealand's forests, survivors of the Cretaceous Era 135 million years ago: araucaria, podocarps and southern beeches. All had close relatives in South America and other parts of the world.

A single species of the Araucaria family, to which the South American Monkey Puzzle Tree belongs, dominated forests on North Island. The enormous Kauri (*Agathis australis*) has a massive, wide trunk that rises to great heights

before branching in a wide canopy. Its gray, grainy bark forms deep, vertical ridges that curve upward, wrapping around the tree as it rises hundreds of feet into the air. Verdant tree ferns, with large, short trunks, and primitive club mosses form an understory beneath them.

Seventeen species of podocarp trees survive in New Zealand, some of which reach great heights. New Zealand's tallest tree is the Kahikatea (*Dacrycarpus dacrydioides*), or New Zealand Cedar, a type of podocarp which is nearly as tall as Coast Redwoods but with a slimmer trunk, often covered in epiphytic plants (Molloy 1994). Podocarp forests were once very widespread throughout both North and South Islands, each species in a slightly different habitat (Molloy 1994). At the other extreme is the world's smallest conifer, the ankle-high Pygmy Pine (*Lepidothamnus laxifolius*), a podocarp growing at high altitudes in a beautiful area known as the Southern Alps on South Island (Molloy 1994). Another podocarp type, the Celery Pines (*Phyllocladus spp*), are small trees whose leaves are actually flattened stems. One podocarp, *Halocarpus kirkii*, is listed as Threatened by the International Union for the Conservation of Nature (IUCN) (Walter and Gillett 1998), and all have declined dramatically in range.

Southern beeches of *Nothofagus*, the same genus as those in South America, once blanketed South Island in dense, canopied forests, often without an understory of plants other than low ferns (Molloy 1994). Today some forests remain, growing in association with broadleafed trees and hardwoods that arrived in New Zealand at a more recent time (Molloy 1994).

Some extremely primitive plants have also survived in New Zealand. The largest moss in the world (*Dawsonia superba*), giant liverworts, clubmosses and horsetails are among these (Molloy 1994). *Tmesipteris*, an epiphyte, is a relict of the earliest vascular plants, which evolved some 400 million years ago. This rootless plant clings to the branches of trees and hangs in vine-like, leafy strings. New Zealand's forest floor plants, a micro-world of species, most of which are less than an inch high, are beautifully photographed and described in *The Forest Carpet* by Bill and Nancy Malcolm (1989), a book devoted to New Zealand's mosses and related plants.

Other survivors from Gondwana include an extremely ancient family of spiders, Archaeidae. First described from a specimen frozen in amber several million years old, seven species have been found on Madagascar, also a part of Gondwana: one in South Africa, three in Australia, five in New Zealand and one at the tip of South America (Preston-Mafham 1991). The Archaeidae spiders have strange, grotesquely shaped bodies, visible only through a microscope since they are only 0.14 inches long; they live among leaf litter on the ground (Preston-Mafham 1991).

The beauty and primitive auras of many of the Kauri, beech, podocarp forests and pristine forest swamps evoke a "bygone era when dinosaurs still roamed the Earth" (Molloy 1994).* Beech and podocarpus forests cover South Island's Fiordland, a region along the southeastern coast resembling Norway's fiords, with inlets penetrating deep inland, lined by misty forests. The trees are buffeted by fierce winds from the west that bring rainfall of up to 20 feet a year. In this rugged wilderness, mosses and huge tree ferns thrive in the dampness.

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*Many of the primitive landscapes that survive in New Zealand were captured in Gerald Cubitt's photos in *Wild New Zealand,* accompanied by natural history information in the text by Les Molloy (1994). Also, two films, fiLand of the Kiwifl and fiMountains of Water,fl described in the Video section, display these vistas.

The moas, which must have been very tame and unafraid, were hunted by the Maoris, who lived on their meat and eggs for centuries. The last of the moas, all smaller species, are said by some authorities to have survived until the 18th and 19th centuries (Greenway 1967), although this is disputed by others who assert that the moas were killed off well before the 15th century (BI 2000). Some Europeans claimed to have seen living moas, but no account was ever confirmed. Millions of their bones and eggs, and a few examples of skin, are all that now remain of these birds. The giant penguin, giant eagle and many flightless birds were also wiped out, apparently by hunting. European settlers eliminated many more species when they cleared forests and imported animals, such as dogs, cats, the weasel-like

stoat that preyed on native animals, and livestock that eliminated their habitats. Apart from the moas, nine birds, one reptile and one mammal are known to have become extinct in New Zealand since 1500. One of the birds, a beautiful forest songbird, the Huia (*Heteralocha acutirostris*), was truly unique: the male and female had different sized and shaped bills. Hunted for its plumes, and with its habitat destroyed, the Huia was last seen in the late 19th century. Others, including a flightless owl; a quail; two wrens, one of which was the only known flightless songbird; a bittern; a thrush; a storm-petrel; a flightless rail; and another songbird became extinct. A gecko and a native bat also disappeared (see Appendix for a chronological list of these species).

Although the Maoris cut and burned portions of the Kauri forests, not until the Europeans arrived in the 18th century did clearcut logging begin. Captain James Cook, the first European to visit New Zealand, noted some very tall trees that were probably Kauris while reconnoitering for lumber on his visit to New Zealand on November 21, 1769: "I judged that there was 356 solid feet of timber in this tree clear of branches." Millions of these great trees were felled for lumber or to clear land, leaving only fragments of the original forests. On the Coromandel Peninsula on North Island, isolated patches of mature Kauri forest are protected in several sanctuaries where old tramways, constructed to remove the logs, still scar the landscape (Molloy 1994).

Overall, approximately 75 percent of native forests in New Zealand have been cleared for agriculture and grazing land for 60 million sheep and other livestock. Fortunately, the Government of New Zealand has set aside many large parks and reserves to preserve landscapes, forests, endemic plants and animals. Thirty percent of the islands are protected, one of the highest rates of preservation in the world. In the majority of western Europe, for example, less than 5 percent of the land is protected, and villages and residences are allowed in many national parks. Not all New Zealand's ancient forests are safe from logging, however. A controlling interest in one of the last sizeable expanses of forest, 193,000 acres on the northern end of South Island owned by Fletcher Challenge Ltd., a logging company, was sold in 1997 to the US lumber company, Weyerhauser.

Many native animals of New Zealand's forests have been pushed to the edge of extinction by a combination of loss of habitat and the introduction of exotic species. Even the weta insects are in decline. Nine weta species are listed on the *1996 IUCN Red List Animals* (Baillie and Groombridge 1996). All four species of kiwis in New Zealand are rapidly approaching extinction, listed as Vulnerable or Endangered by *Threatened Birds of the World* (BI 2000). Authorities now recognize four, rather than three kinds of kiwi, and one, the Brown Kiwi (*Apteryx mantelli*), is endangered, its population having declined 90 percent since 1900 (BI 2000). Among the most ancient of bird species and possessing many unique physical and behavioral characteristics, their loss would represent as important a biological tragedy as the extinction of the moas. They have been placed in their own family, Apterygidae, an indication of their uniqueness. These flightless birds, which weigh from about 2 to 10 pounds, have small, stunted wings with claws on the end that are hidden beneath a cloak of shaggy, brown, hair-like plumage, giving them a mammalian appearance. Their long, pointed, ivory-colored bills are used to probe the leaf litter on the forest floor for earthworms and other invertebrates at night, and they can be heard snuffling as they forage. They have short, strong legs, and long, sharp claws on their toes, used for digging and fighting (Heather and Robertson 1997). Their food supply is ample: 200 species of earthworms live in New Zealand, with the largest species measuring an amazing 40 inches in length and 4 inches in diameter (Molloy 1994).

At the end of the kiwis' bills are nasal openings for their highly developed sense of smell, which aid them in detecting their prey. An acute sense of smell is a highly unusual trait in a bird. Kiwis also have sharp hearing but poor eyesight. Such characteristics are more common in mammals than birds (Hoyo *et al.,* 1992). Kiwis possess other mammal-like traits, such as two functionally alternating ovaries rather than one in the female (Feduccia 1996). In an interesting evolutionary phenomenon, where land mammals are absent, animals totally unrelated to them often develop mammal-like traits. Kiwis mate for life and live in large burrows. The single egg laid by the female is enormous in proportion to her size, weighing 20 to 25 percent of her weight. It is the largest egg, proportionally, of any bird and four times the size that would be expected for a bird her size (Hoyo *et al.* 1992). By comparison, a human mother weighing 125 pounds would have to bear a 25- to 30-pound baby. The hatching process is long and arduous, taking two to three days from the time the chick begins to break out; because the chick lacks an egg tooth, it

must kick its way out of the shell with its feet (Hoyo *et al.* 1992). Many chicks die during this process. When the chick emerges at last with damp feathers, its yolk sack is still connected and nourishes it for several days. A miniature version of its parents, it is able to follow them on their nocturnal feeding trips within a few days (Hoyo *et al.* 1992). (Rare footage of incubation and hatching of a kiwi in the wild can be seen in fiBirds of Paradox.fl See Video section F, Birds.)

Kiwis are totally unable to protect themselves against predators, such as dogs, cats, stoats and introduced Australian Brush-tailed Possums (*Trichosurus vulpecula*), who kill them or prey on their eggs (BI 2000). At least 94 percent of kiwis die before adulthood as a result of this predation (BI 2000). The possums also destroy rainforest vegetation by browsing on canopy leaves, epiphytic and ground plants; they have exterminated a native mistletoe (Molloy 1994). Non-indigenous animals have effectively eliminated kiwis from all but a few remote parts of their original ranges. At least one reserve, the 290-square-mile Coromandel Forest Park, has erected a fence within the Kauri forest to keep out possums, protecting kiwis and other native birds (Molloy 1994). Elsewhere, kiwis are being killed by predators; official government protection since 1908 has not stopped their continued decline. Feral dogs killed 500 Brown Kiwis in a population of 900 in less than two months in the early 1990s (Hoyo *et al.* 1992). Another cause of mortality has been steel-jaw leghold traps and poison set out to capture Brush-tailed Possums, although recently the use of traps has been regulated to prohibit any possible capture of kiwis (Hoyo *et al.* 1992). Dependence on humid rainforest habitat has also been a major factor in their disappearance, as this habitat has been destroyed by logging, fire and agriculture (Hoyo *et al.* 1992). Many kiwis are burned to death in the intentionally set fires that follow logging operations, as their shallow burrows do not protect them from the smoke, heat and flames. Often they are afield when fires are set and die in the fires. Those not killed lose their habitat when the humus and leaf litter essential for their feeding is consumed in the fires.

The Little Spotted Kiwi (*Apteryx ownii*) is the smallest and rarest kiwi, numbering only about 1,100 birds (BI 2000). A population of about 950 birds inhabits the 20-square-kilometer Kapiti Island off the southwest coast of North Island (Collar *et al.* 1994), where it was introduced from the mainland. Another introduced population on Tiritiri Matangi Island, a sanctuary of 543 acres off the northern coast of North Island, has adapted well (Molloy 1994). At one time, this kiwi was found throughout the main islands (Hoyo *et al.* 1992). In the summer of 2000, Little Spotted Kiwis were returned to a reserve on the mainland, a step toward their recovery. The Great Spotted Kiwi (*Apteryx haastii*), the largest species, is confined to forests in extreme northwestern South Island in the southern Alps (Heather and Robertson 1997). Although its habitat here is protected, its numbers are still declining from predation (Collar *et al.* 1994). At present, no Great Spotted Kiwis are living on a predator-free out-island (Heather and Robertson 1997), and only one small population is protected by controlling predators (BI 2000).

Another highly endangered bird, and a species almost as bizarre as the kiwi, is the Kakapo or Owl Parrot (*Strigops habroptilus*). The world's heaviest parrot, it weighs up to 3.5 kilograms and is the only living flightless member of the parrot family. It is also one of the rarest birds in the world. Once native to all but the highest mountain altitudes on North, South and Stewart Islands, Kakapos probably numbered in the tens of thousands (Collar *et al.* 1994, Forshaw 1989). They may have flown to the islands at a very early date, long before the land split into North and South Islands, and gradually lost their ability to fly. These 2-foot-long parrots have dull green plumage, mottled with brown, that blends into the vegetation of their rainforest habitat. Known as the Owl Parrot because of large eye discs and nocturnal habits, the Kakapo has another distinction in being the only member of the parrot family to gather in male groups near a bare area where "lek" displays are performed for females during breeding season. Males call females to the lek with loud, low-frequency, booming sounds emanating from their thoracic air sacs. These calls are audible to humans from as far as 3 miles away (Molloy 1994). They perform these booming calls for six to eight hours a night throughout the three- to five-month breeding season, which takes place only every three to five years under normal conditions (Heather and Robertson 1997). Very placid and slow-moving, they are unable to defend themselves against the rats, cats, stoats and dogs that Europeans brought to the main islands.

The range of the Kakapo began shrinking with the arrival of Maoris and their domestic animals, but in 1800 they were still common in central North Island and parts of South Island where their habitats had not been destroyed

(Heather and Robertson 1997). The European Stoat, introduced to the islands in the 1880s, proved an efficient predator of these parrots, eliminating them entirely from North Island and all but remote parts of South Island. In 1970, a survey revealed that only 18 Kakapos remained--all males--in Fiordland, South Island, and these last birds were gone by the early 1990s (Heather and Robertson 1997).

Fortunately, a previously unknown population of 100 birds was discovered in 1977 on Stewart Island, a fairly large island due south of South Island, but these birds were under attack from feral cats (Heather and Robertson 1997). After a decade of decline, all the remaining 61 Kakapos were transferred from Stewart Island by the New Zealand wildlife department to predator-free islets located off North and South Islands (Heather and Robertson 1997). In 1997, a lone female was discovered on Stewart Island and was removed (BI 2000). This rendered the species extinct throughout its original range. Unfortunately, many of the parrots starved to death in their new environments because these islets lacked sufficient food. Their natural diet of fruits, berries, nuts, fern fronds, roots, tubers, moss and fungi was abundant in the temperate rainforests and tussock grasslands of the main islands. A 1983 BBC documentary, fiBirds of Paradoxfl (see Video section), filmed a Kakapo chick being fed by its mother, who walked over steep terrain 3 miles each night to obtain seeds and other food for her offspring. Kakapos can live for as long as 70 years, and this longevity has prevented their extinction, since many years pass without any successful breeding. New Zealand wildlife officials finally provided supplemental feeding, which immediately resulted in the first surviving chicks in a decade in 1991. A population of 62 birds survived in 1999, of which 26 were females and 36 males, including six chicks (WC 2000). Although their numbers are slowly growing, many of the males appear to be sterile, and others have been filmed calling alone, rather than in male groups; some seem to be calling in vain, with no females responding (Hynum 1999). An Internet website has been established to monitor these extraordinary birds: www.kakapo.net.

Many other native songbirds, shorebirds, reptiles and amphibians are threatened in New Zealand, and some survive only on offshore islets where predators are absent or have been eliminated. New Zealand has had success in eliminating cats and possums from several sizeable islands off the main islands, but on North and South Islands, rats, cats and stoats, as well as European deer and goats, are uncontrolled (Molloy 1994). Some 70 million Brush-tailed Possums live throughout both islands, and they are now endangering forest birds by preying on eggs and chicks (Molloy 1994). Exotic plants have also invaded forests, smothering native plants and choking lakes (Molloy 1994). There is, however, a remarkable awareness in New Zealand of these conservation problems and its extraordinary natural heritage. Moreover, the government agencies dealing with wildlife and the environment, TV New Zealand Natural History (which makes superb wildlife films), and scientist-writers such as Les Molloy (1994) are educating the public about this natural legacy, much of which has endured for hundreds of millions of years. Contributions of funds and expertise from many nations and organizations might aid New Zealanders in their conservation work.

Australia

Australia's temperate rainforests are very similar to those in New Zealand, and fragments persist in portions of eastern and southeastern Australia. Relatives of the Kauri, the Nothofagus beeches, and podocarpus trees are native. An exciting botanical discovery was made in one of these forests in 1994. Named the Wollemia Tree (*Wollemia noblei*) after the national park where it was discovered, it is a member of the Araucaria family and somehow escaped attention until 1994. A species familiar to botanists through fossil records, it was thought to have become extinct 50 million years ago (Wilford 1994). A botanist noticed an unusual tree in Wollemi National Park in New South Wales, southeastern Australia and, when he investigated closely, found its fern-like leaves and other proof that it was indeed a living fossil (Wilford 1994). About 23 of these "living fossils" have been located in the park, the tallest towering 130 feet with a 10-foot girth and the species is being propagated by the Australian government. At a press conference soon after its discovery, Ken Hill, botanist at the Royal Botanic Gardens in Sydney, exhibited a fossil imprint of the Wollemia's fern-like leaves next to the living branches for news media, stating that it was one of the outstanding

biological discoveries of the century (Wilford 1994). Pictures of these trees were shown on television news programs around the world, an indication of the new appreciation being accorded such natural wonders. These massive pines have dense, waxy foliage and knobby, dark bark with strange-shaped branches growing from the trunk (Wilford 1994). They were found growing in a secluded area of little more than an acre, deep in the national park, where high humidity and moisture probably protected them from fire and provided ideal habitat (Wilford 1994). Had these priceless trees not survived in a national park, they might have been cut for firewood or commercial logs long ago. Wollemi National Park's protection was considered a great triumph for Australian conservationists. It contains the country's largest area of undisturbed forest--more than 486,400 hectares (1,201,894 acres) (Campbell 1989). The Colo River, the last unpolluted waterway in New South Wales, flows through the park. Other trees in this park include tall eucalyptus, which predominate; Snow Gums; Mallees; and pockets of rainforest in gullies (Campbell 1989).

Four species of Australian Podocarps are listed by the *1997 IUCN Red List Plants*. They range from Queensland's rainforests to temperate rainforests in New South Wales and Tasmania. Such forests, with their tall, evergreen trees and understories of tree ferns, are very rare today as a result of climatic change, a gradual drying of the continent and logging. Eucalyptus trees, which can withstand a dryer climate, gradually increased in range in Australia's temperate rainforests since they appeared in the Oligocene Epoch 35 million years ago (Vandenbeld 1988). They first colonized forest edges and flourished in open woodlands, then grew into entire forests growing from Queensland south to Tasmania, having radiated into 500 species (Vandenbeld 1988).

From New South Wales south to Tasmania, Nothofagus beech forests have been edged out by eucalyptus but remain in a few areas, a glimpse of the past. Mosses, ragworts, rotting logs, ferns and tree ferns carpet the forest floor, similar to those growing farther east in southern New Zealand (Vandenbeld 1988). European colonists logged these forests to clear the land for farms and grazing. The ancient eucalyptus, with their massive trunks, dwarfed the teams of oxen that dragged out the logs. This primeval forest is now almost gone. A 19th century artist, Isaac Whitehead, depicted a magnificent old-growth forest being logged in a dramatic painting showing trees that must have had circumferences of well over 50 feet. If not for the huge stumps that remain, one might have doubted that they actually existed (Vandenbeld 1988).

Forty percent of the country's forests have been cleared, including 75 percent of the rainforests in northern Queensland and 90 percent of both the dry mallee of the south and the eastern temperate woodlands (Parfit 2000). Logging had a devastating effect on the continent's woodland mammals who depended on the forests for survival. Of 144 marsupials inhabiting Australia 200 years ago, 21 are extinct, and a total of 88 Australian marsupials are listed in the *2000 IUCN Red List Species*. Many of these were forest species. Australia has had more mammals become extinct over the past few centuries than any other country in the world. The majority of forests in Australia did not revert to second-growth but became grazing land, plantations, agricultural fields, or tree farms of non-native pines for pulpwood (Vandenbeld 1988).

The eucalyptus forests that came to dominate many of Australia's woodlands are interspersed with savannah in the dryer north. In the south, they grow in dense, moist woodlands, with tree ferns and mosses as ground cover. Among the most characteristic trees of Australia, almost all the great old specimens are gone. Few Australians have ever seen a gigantic, 400-year-old eucalyptus tree, so massive that it takes 15 people to embrace its girth, but such trees were once common (Sharp 1995). It takes 200 to 300 years for a eucalyptus to form nesting holes that provide homes for possums, gliders, bats, snakes, birds, parrots and other creatures that were once prolific in Australia (Sharp 1995). The tallest trees in Australia, many eucalyptus stand more than 300 feet high (Attenborough 1995). In 1880, just before cutting it down, a surveyor measured a eucalyptus that stood 375 feet tall; another inspector around the same time told of a fallen trunk that was 435 feet long (Attenborough 1995). Had this been confirmed, it would have been the world record for the tallest tree ever measured (Attenborough 1995). Their straight, unlimbed trunks rise to great heights before branching. Settlers cut them for building materials and railroad ties, clearing vast areas and threatening many species. An astounding 175 species of the genus *Eucalyptus* are listed on the *1997 IUCN Red List Plants*.

In central Queensland, 5 billion eucalyptus trees were cut to create permanent grazing land for up to 2 million

cattle. Up to half of the trees in 100 million hectares in this Australian state have been cut (Arnold 1994). The last forests of Queensland are being cleared for livestock and agriculture at one of the highest rates of deforestation in the world, estimated at 840,000 acres a year (Parfit 2000).

Koalas (*Phascolarctus cinereus*), native to eastern Australia's eucalyptus forests, are entirely dependent on the leaves of these trees for their food. Most animals avoid eucalyptus because the leaves contain toxic oils, but Koalas have the ability to detoxify these oils, which also gives them a natural insect repellant (Berra 1998). They eat about 36 species of eucalyptus and obtain most of their moisture from dew and the leaves (Berra 1998). Forest clearing has had a disastrous effect on their populations. The last large population of Koalas in southeast Queensland was decimated by construction of an expressway, over vehement opposition from citizen groups (Arnold 1994). Likewise, in the state of Victoria in the southeast, Koalas have been reduced to a few remnant colonies as a result of hunting, development, tree cutting, highways, fires, droughts and predation by dogs and foxes. At least 4,000 Koalas are reported killed each year, and about 2,500 of these die after being struck by cars near urban areas (Berra 1998). They have also been victims of a variety of illnesses, including *Chlamydia*, which causes reproductive failure, pneumonia, blindness and other ailments (Berra 1998). They have declined so dramatically that in 2000 the species was listed as Threatened on the US Endangered Species Act.

Outside of protected areas, the last old-growth forests in New South Wales are being cut. The government accorded a giant multinational corporation, Boral, a contract to cut 500,000 tons of woodchips in the mid-1990s. (Arnold 1994). This logging will remove virtually every native forest not protected in national parks in northeast New South Wales, according to Sue Arnold, Coordinator of Australians for Animals (Arnold 1994).

Victoria still retains some old-growth forest, home to a host of rare animals. Old eucalyptus tower over tree ferns, sassafras, mountain pepper and mosses. In 1999 and 2000, loggers began cutting one of the last of these forests known as the Goolengook Forest (*EarthFirst! Journal* 2000). Aborigines have been able to stop logging in some traditional areas, including East Gippsland, Victoria, but the delicate and endangered native marsupials inhabiting most of these forests may not survive for long.

A strange mammal of Victoria's eucalyptus forests is Leadbeater's Possum (*Gymnobelideus leadbeateri*). Native to the Central Highlands, it lives in colonies in tall, old-growth eucalyptus trees (Strahan 1995). Thought extinct, this marsupial was rediscovered in 1961. With a tail almost twice the size of its body, huge black eyes and a stripe down its back, this possum looks like a cross between a squirrel and a skunk. Each night, it emerges from tree hollows to climb tall trees in search of insects. Forest clearing has destroyed much of its mountain forests (Nowak 1999). Only about 5,000 or fewer Leadbeater's Possums survive, and the species continues to decline as logging clears its habitat (Kennedy 1992). Its dependence on large trees, especially those 300 or more years old which have large tree holes for their nests, has made it very rare (Strahan 1995). Specializing in finding crickets, beetles, spiders and other arthropods beneath the shedding bark of eucalyptus and other trees, it may require, for an as yet unknown reason, a particular species of tree cricket which shelters under the bark of a certain type of eucalyptus (Strahan 1995). This possum also eats gum and tree sap. Less than 3 percent of its total range of 4,000 square kilometers is protected in nature reserves, and 75 percent is located in timber-production forests where tall, old trees are likely to be cut (Strahan 1995).

Tropical Forests

Tropical forests have, for the most part, evolved in stable environments over a period of millions of years, untouched by the recent Ice Ages. The oldest forests on Earth may be in Borneo where the same species of towering trees have been growing for 250 million years. Climates in tropical forests tend to be uniformly warm year-round, with half the year rainy, and the other half dryer but not without rain. Tropical trees generate enormous amounts of

moisture. In some parts of the world, the climate has changed over the ages, resulting in islands of forests surrounded by grassland or other habitats. Many scientists theorize that some forests, including the Amazon and African rainforests, went through such climatic changes during the Ice Ages (Collins 1990). Isolation might explain the evolution of a great number of endemic species in these regions, which today are continuous forest. These tropical forests are showcases of evolution.

Tropical forests vary greatly according to altitude, region and species of trees. Each has a different micro-climate, soil type, fauna and flora. They grow in tropical latitudes 30 degrees to the north and south of the Equator (Collins 1990). Among the many types of tropical forests are evergreen wet forests, deciduous dry forests, mountain cloud forests, and mixed lowland rainforests. In general, lowland rainforests are the most biologically diverse, as well as the most endangered. Covering only 7 percent of the Earth's surface, rainforests harbor half its species (Lean and Hinrichsen 1992). Biological research in tropical forests has consistently shown that this great diversity helps stabilize ecosystems and the very life support systems of the planet.

Some tropical forests have been characterized as "hotspots," having exceptionally high diversity of endemic species that are found nowhere else on Earth. All are threatened by deforestation. Two studies by ecologist Norman Myers in 1988 identified 10 highly endangered and biologically diverse tropical forest hotspots in the world; in 1990, he revised that number to 18 (Myers 1988, 1990; McNeely *et al.* 1990, Mittermeier *et al*. 1999a). Myers pointed out that the 10 hotspots named covered only 0.2 percent of the land surface of the world, but contained 27 percent of the plants and also a high percentage of endemic species. *Hotspots*, a book by Russell Mittermeier, President of Conservation International, and other biologists and ecologists, describes 15 tropical forest hotspots throughout the world among a total of 25 hotspots of all types of ecosystems. The high diversity in tropical forests is reflected in the fact that these hotspots covered 61 percent of the land area of all hotspots identified in the study. Many have lost 90 percent or more of their original forests and continue to decline. Originally, these extremely diverse tropical forests covered 10,635,513 square kilometers; at present, only 1,246,538 square kilometers remain, a loss of 86 percent (Mittermeier *et al.* 1999a). These tropical forest hotspots cover only 0.08 percent of Earth, but harbor 205,789 plant species and 21,903 vertebrate species other than fish (Mittermeier *et. al.* 1999a), a large percentage of the some 248,428 named vascular plants and 23,524 non-fish vertebrates (Wilson 1988). One can only wonder what diversity these areas had prior to their near-destruction. Such astounding facts should result in strong programs to preserve these regions, all of which are being degraded.

The tropical forest hotspots include the Caribbean, Central America, Brazil's Atlantic Rainforest, western Ecuador's Choco region, Andean tropical forests, Indo-Burma, the Philippines, Indonesia and Peninsular Malaysia, the Western Ghats of India, Madagascar, New Caledonia, Polynesia and Micronesia, Guinean Forests of West Africa, and mountains and coastal forests of Tanzania and Kenya (Mittermeier *et al.* 1999).

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The richest and most diverse hotspot on Earth is found in the tropical Andes, stretching from western Venezuela to Chile and Argentina (Mittermeier *et al.* 1999a). This area has innumerable isolated valleys, slopes, and peaks in many altitudes, all physical characteristics that contribute to the evolution of a great array of plants and animals. Covering 1,258,000 square kilometers, these forests are interspersed with alpine vegetation and grassland. Between 45,000 and 50,000 kinds of plants are found here, 20,000 of which are found nowhere else (Mittermeier *et al.* 1999a). Birdlife is prolific, with 1,666 species, 41 percent of which are endemic. Andean Cock-of-the-Rocks (*Rupicola peruviana*), threatened Toucan Barbets (*Semnornis ramphastinus*), the giant Andean Condor (*Vultur gryphus*), also a threatened species, and the greatest variety of hummingbirds in the world are resident (Mittermeier *et al.* 1999a). The critically endangered Yellow-tailed Woolly Monkey (*Lagothrix flavicauda*) is native to a few Peruvian cloud forests, and the Spectacled Bear (*Tremarctos ornatus*) and Mountain Tapir (*Tapirus pinchaque*) are other endangered species of the region. Deforestation has destroyed much of the region through slash-and-burn farming and extensive cultivation of opium poppies, which are controlled with herbicides that poison rivers and streams, suspected to cause declines in frogs and toads (Mittermeier *et al.* 1999a). Several national parks have been set aside, including the Madidi and Tambopota National Parks on the Peru-Bolivia border, covering some 2,225,000 hectares.

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The Atlantic forest of southeastern Brazil, another hotspot, has been reduced by 92 percent, yet it has been found to contain the greatest diversity of trees in the world: 476 species in a plot of only 2.5 acres, including 104 previously unknown tree species. By contrast, a plot of similar size in a North American temperate forest has only about 20 species of trees. A much larger plot, totaling 129 acres, in an old-growth forest in Malaysia's Lambir Hills National Park has an astounding 1,175 tree species (NGS 1997). This site is surrounded by farms, and nearby forests have been logged to the forest's boundaries. Both sites are tropical forest hotspots.

Africa's tropical forests once stretched in a wide band from Sierra Leone east through Zaire to Uganda and Kenya, and south to Angola. Of the original 3,620,000 square kilometers, less than half, or about 1,760,000 square kilometers, remained in the early 1990s (Martin 1991). The worst damage has occurred in West Africa where logging and clearance for plantations and villages have destroyed at least 85 percent of its rainforests (Collins 1990, Mittermeier *et al.* 1999a). Even the now-extensive forests of the Democratic Republic of the Congo and neighboring countries are being logged so rapidly that, outside reserves, they will have disappeared in 50 years, according to a 1997 study. A primate anthropologist, John F. Oates, researched the destruction of West African forests and the role played by international loan agencies such as the World Bank and the Ford Foundation. His book, *Myth and Reality in the Rain Forest. How Conservation Strategies Are Failing in West Africa* (Oates 1999), carefully documents the establishment of forest sanctuaries that did not protect forests and their wildlife, but encouraged logging, farming and bushmeat hunting. Almost no forest or sanctuary in West Africa is protected from logging, wildlife killing or capture, or other destruction. The rainforests stretching from Sierra Leone east to western Cameroon and the Gulf of Guinea islands of Equatorial Guinea comprise one of the world's most endangered hotspots for biological diversity (Mittermeier *et al.* 1999a). They covered 1,265,000 square kilometers a few hundred years ago, but have been reduced to only 182,348 square kilometers, or 14.4 percent of the original; of the remaining forests, only about 126,500 square kilometers are pristine forest, a scant 10 percent of the original (Mittermeier *et al*. 1999a). These forests are fragmented and largely unprotected. Some 9,000 species of plants exist in this region, of which 2,250 are endemic (Mittermeier *et al*. 1999a).

Some of the world's most fascinating and unusual wildlife species can be found here as well, including the world's largest frog, the threatened, 3.3 kilogram Goliath Frog (*Conraua goliath*), which inhabits mountain streams in Cameroon. The Western Chimpanzee (*Pan troglodytes verus*) of these forests is highly endangered by forest clearance and killing for the meat trade. Like the Chimpanzees of Kenya studied by Jane Goodall, they are tool-using, employing stones to crack open hard nuts on logs. They may be a completely different species of chimpanzee (Mittermeier *et al.* 1999a). Forest Elephants (*Loxodonta africana cyclotis*) are vital to forest ecosystems as seed dispersers and to open up forest glades for wildlife, such as the threatened White-breasted Guineafowl (*Agelastes meleagrides*) (Kingdon 1989). They also dig waterholes which provide a lifeline for a host of animals. Unfortunately, they are endangered as a result of deforestation and poaching. These forests also harbor many species of little forest antelope known as duikers, all less than 3 feet tall, which dart about the undergrowth in the Guinean forests. Sixteen of the 17 species are listed in the *2000 IUCN Red List Species*, declining from forest loss and intense hunting. The rarest is Jentink's Duiker (*Cephalophus jentinki*), of which only a few hundred remain. There are no individuals of this species in captivity, and no photo has ever been published of this little antelope (Martin 1991).

In spite of these extraordinary treasures, there are few national parks in the Guinean forests, and almost all remaining forests are being commercially logged. In Sierra Leone, the only protected area is Tiwai Island, a 12-square-kilometer, primate-rich area (Mittermeier *et al.* 1999a). The parks that have been set aside, such as the Tai National Park, an extremely important and biologically rich forest in the Ivory Coast, are under siege from illegal hunters, and farmers whittling away at the forest. Kakum National Park in Ghana has been aided by Conservation International in promoting ecotourism over the past six years; a new canopy walk and aid in tourist promotion helped attract 40,000 tourists in 1997 (Mittermeier *et al.* 1999a). Few of the existing preserves are large enough to preserve the diversity of wildlife and plants of the region. Unless dramatic action is taken, many extinctions will take place in the near future.

In Gabon, to the south of Cameroon, recent progress has been made in protecting a large block of forest in the

center of the country. Lope Reserve covers 1,900 square miles of Equatorial jungle coveted by loggers. An agreement signed in July 2000 between logging companies, the government and a variety of environmental organizations permanently prohibited logging in this sizeable area (Revkin 2000a). A compromise included the removal of 400 square miles of the reserve area with valuable Okoume Tree (*Aucoumea klaineana*) in order to add 200 square miles of extremely important habitat for primates, elephants and other wildlife (Revkin 2000a). Since 1957 when only a small percentage of Gabon's forests were open for logging, to the present when almost all the country is logged, wildlife has been driven from many areas by logging noise, roads that open up the forest to hunters and loss of habitat (Revkin 2000a). Dr. Lee J.T. White of the Wildlife Conservation Society has documented this phenomenon and has convinced the government to approve a country-wide forest inventory to identify other areas to protect for a network of national parks (Revkin 2000a).

The Lope Reserve, according to zoologist Jonathan Kingdon, does not include the Bee Forest, home to a very beautiful and rare primate, the Sun-tailed Guenon (*Cercopithecus solatus*), first classified and named in 1984. Dramatically patterned in dark gray with white facial markings and long reddish tails, these monkeys were photographed in the mid-1990s lying dead on tables at a market in Libreville, Gabon, offered for sale as meat (Bohan *et al.* 1996). Known only from this forest, this monkey is threatened by heavy logging in the forest by Isoroy, a French company acquired by Glunz Corporation of Germany (Bohan *et al.* 1996). The species is classified as Vulnerable in the *2000 IUCN Red List Species* (Hilton-Taylor 2000). Isoroy cuts about 140,000 cubic meters of logs per year from a 300,000-hectare (741,300-acre) concession in the Bee Forest, exporting logs to plywood factories in Europe (Bohan *et al.* 1996). The prime wood sought by the loggers is from the Okoume Tree, and a four-year study has found major damage being done to the forest in the process. On average, 8.5 trees were destroyed for every Okoume log harvested, and 49 percent of the forest canopy has been disrupted (Bohan *et al.* 1996).

The Sun-tailed Guenon is one of 26 species of guenons considered "refugia" species of African rainforests. During the Ice Ages, these forests shrank into islands, where many different primates evolved in isolation in these forest fragments. Each has brightly marked facial and body patterns (Kingdon 1989, 1997). These "masked monkeys," many of which were photographed in the spectacular PBS Nature film of that name, are often highly restricted in their ranges and considered threatened by the IUCN. Kingdon, who has studied these primates for decades, believes that they have brightly colored markings in order to see and identify one another in the dark forest foliage (Kingdon 1989).

A close relative of the Sun-tailed Guenon is the endangered Diana Monkey (*Cercopithecus roloway*), endemic to the Guinean region. This lovely primate's jet black face contrasts with its white chest and legs; its back is russet red and gray, and its long tail is black. Its fur seems to have been painted on, so silky and lustrous is its texture. The majority of Americans know little about this species and other endangered African monkeys. This was dramatically illustrated in the summer of 2000 when New York state authorities ordered the confiscation of a pet Diana Monkey kept by an immigrant family. This animal had been bought in a Long Island pet store in 1995, long after its listing on the US Endangered Species Act and New York's endangered species legislation, yet no one seemed to notice when it was offered for sale illegally. The new owners immediately had a veterinarian spay and remove the canine teeth from this female monkey, named her "Cookie" and dressed her in tutus as a family pet. They said they had no idea that she was an endangered species and refused to give her to the state, which planned to place her in the Detroit Zoo with a male of the species. She can never be part of a breeding program, however, and is a genetic loss to the species. Had the plight of these beautiful primates been better recognized and the species better known, this unfortunate incident would never have happened.

Another "masked monkey" native to Ghana and the Ivory Coast has recently been declared extinct, the first primate extinction in several centuries (Revkin 2000b). Known as Miss Waldron's Red Colobus (*Procolobus badius waldroni*), this monkey had colorful, reddish-brown legs and head, and charcoal body. Last seen in the 1970s, deforestation and hunting caused its extinction; thorough searches over seven years within its habitat proved fruitless (Revkin 2000b). Had it been protected in a forest reserve, this colorful monkey would have avoided extinction (Revkin 2000b). This extinction is likely to be followed in the near future by those of many other critically

endangered primates as a result of logging and hunting.

The deforestation of Central and West Africa also presents dangers for people. Many scientists warned that an inevitable consequence of opening up Africa's tropical rainforest through logging was the eruption of ebola virus and other diseases carried by native mammals. Such warnings went unheeded, and several outbreaks of the highly contagious and nearly always fatal ebola virus have occurred. Meat hunting of Chimpanzees in Gabon was a source of this virus, which has killed hundreds of people (French 1996).

The number of threatened vertebrates native to tropical forests of all types has grown astronomically in the past 20 years, concurrent with their widespread destruction. Indonesia, Brazil, Peru, Ecuador, India, Madagascar and Mexico are among the countries with the greatest number of endangered species, enormous diversity, and significant losses of tropical forest cover.

Among the hardest hit of tropical mammals are the primates. Ninety percent of all species inhabit tropical forests, and recent surveys have found that 204 species, or one-third of the world's 650 taxa (taxonomic listing including subspecies), are in high degrees of threat; 103 are critically endangered or endangered (Mittermeier *et al.* 1999b). In Southeast Asia, 90 percent of primates are either threatened or near-threatened, an amazingly high rate of endangerment. Primates are in rapid decline as a result of forest loss, killing for the pet trade, hunting for meat, and capture for zoos, the pet trade and research (Mittermeier *et al.* 1999b). The combination of all these factors has pushed some species so close to extinction that some primate species and subspecies have total world populations of fewer than 100 animals (Mittermeier *et al.* 1999).

Focus on Indonesia

Indonesia has the greatest biological diversity in Asia. A vast mosaic of 13,667 islands, Indonesia links two biogeographic regions known as the Sunda subregion, an area stretching from southern Burma and Thailand south to northern Indonesia and Borneo, with Oceania to the south and east. The political boundaries of Indonesia have little to do with ecosystems or ethnic cultures. The giant island of Borneo, for example, has been divided among several Asian countries. Indonesia claims the southern two•thirds, known as Kalimantan, while Malaysia rules two states in the north and west, Sabah and Sarawak, and the small independent country of Brunei lies on the northwestern coast. Likewise, New Guinea, whose Melanesian tribes have inhabited the island for thousands of years, has been divided between Indonesia, which rules with a strong military presence in the western half, Irian Jaya, and Papua New Guinea in the east, an independent nation. Politically, Indonesia has been in turmoil for decades, with a series of presidents who have grown rich on foreign aid and siphoning off profits from exploitation of timber, oil and minerals.

Focus on Indonesia: Page 1

The world's greatest variety of palm species grows in Indonesia along with 10,000 kinds of trees and 25,000 species of flowering plants (Collins *et al.* 1991). About 40 percent of its plants exist nowhere else, and its forests have a diversity of plants equaled only in Amazonia (Collins *et al.* 1991). One high-altitude forest on Borneo, Mount Kinabalu, has 70 species of oaks, and more than 100 grow on the island, along with 30 kinds of squirrels who feed on their acorns. Such trees are usually considered temperate forest species, but in these forests, which vary greatly in altitude and habitat type, an incredible variety grows. Two thousand species of orchids grow on Borneo (Mittermeier *et al.* 1999a). At high altitudes on Mount Kinabalu, the soggy ground is 90 percent covered in orchids, some with flowers as tiny as grains of rice (Lanting 2000).

Forests cover 85 percent of New Guinea (O'Neill 1996), the majority of which are humid, with very rich diversity in the lowlands. Above 750 meters, oaks and Araucaria trees related to those in South America's Atlantic Forest grow. Even higher, above 2,000 meters, tangles of bamboo and *Nothofagus* beech trees grow in great stands (Beehler *et al.* 1986). New Guinea's mountains rise above 4,200 meters, where alpine shrubbery and boggy grassland dominate. Mangrove forest fringes most coastal areas (Beehler *et al*. 1986).

Until the beginning of the 20th century, forests of many types covered most of Indonesia. The isolation of many of the islands from one another resulted in a radiation of evolution in all types of plants and animals. Many species of animals that had become extinct or rare on mainland Asia still thrived in Indonesia--rhinoceros, Asian Elephants, Tigers and Orangutans, for example. Other mammals, such as the extraordinary, long-nosed Proboscis Monkey (*Nasalis larvatus*), evolved among the mangrove swamps of Borneo. An unparalleled beauty and wealth of birds had evolved. Among these were birds-of-paradise, parrots, lories and cockatoos, colorful songbirds and hornbills. As the 21st century dawns, however, this diversity is in ruins, with many plants and animals close to extinction. The small original populations of many of the endemic species made them highly vulnerable to loss of habitat as the ancient trees were felled, and population growth consumed millions of acres for agriculture.

Of more than 1,500 species of birds native to the islands of Indonesia, or 17 percent of the world's avifauna, 430 are endemic to the country (Collins 1990). Indonesia has twice the number of breeding birds as North America in only one-fifth the land area. Many of these birds live on only one or two small islands. About 164 species are endemic to the Sunda subregion alone. The great loss of forest and other types of habitats in Indonesia is perhaps the most important cause threatening 319 species of native birds, of which 114 are extremely threatened (BI 2000). This is the largest number of threatened birds of any country in the world. Further field research may uncover even more species to add to this list, especially in view of the accelerating deforestation in Kalimantan**,** Sumatra and New Guinea.

Two hundred and one of Indonesia's 436 species of mammals--almost half-- are endemic, an amazingly high rate of endemism (Baillie and Groombridge 1996). Not surprisingly, Indonesia also leads the world in the number of threatened mammals--135 species, or 31 percent of all of its native mammals (Hilton-Taylor 2000). One thousand species of reptiles and amphibians live in Indonesia, 10 percent of the world's 10,484 herpetofauna (Collins 1990). Twenty-eight species of reptiles are considered threatened by the *2000 IUCN Red List Species*, along with at least 59 species of freshwater fish. Research on endangered amphibians, fish and invertebrates in tropical countries lags far behind that in temperate areas, and the endangered list of the latter species is likely to grow when further research is done.

Focus on Indonesia: Page 2

New Guinea has some of the largest expanses of ancient species of trees in the world, most of which grow in cool climates in highlands and mountains. One species of *Agathis* kauri from the highlands of Papua New Guinea is considered rare by the *1997 IUCN Red List Plants*, as are two more *Agathis* species in the Solomon Islands and Vanuatu to the southeast of New Guinea, also bits of Gondwana. The kauri pines (*Agathis macrophylla*) occur on both the latter island groups but have been logged over. Their close relatives on the island of Borneo are in steep decline from logging and land clearance. In New Guinea, logging and clearance for settlements or agriculture, and even native tribes, are destroying these giant trees. Known as "timber trees" in the IUCN-sponsored *Conservation Atlas of Tropical Forests. Asia and the Pacific* (Collins *et al.* 1991), the *Araucaria* pines, relatives of the Monkey Puzzle Tree, grow in groves in parts of New Guinea's highlands, and some tribes venerate them.

Zoologist Tim Flannery (1998) walked among these *Araucaria* trees near the highland village of Telefolip and reflected: "Around the edge of the grove they were saplings but, further in, the pines were soaring giants, mist swirling through their crowns. Their straight, clean boles carried patches of bright green moss, which contrasted with their walnut-colored bark . . . The most striking thing about the grove was the quality of the sound. It seemed as if, in an instant, we had left the noisy, muddy world of drizzle and people and entered a large, open-air cathedral." The grove was considered so sacred by the local tribe that not a single leaf, not even a mosquito, could be disturbed in it (Flannery 1998). They thought that all life had begun in the grove. In the middle of the grove, Flannery saw a rare bird of paradise displaying. The male Splendid Astrapia (*Astrapia splendidissima*) has iridescent colors on the breast and head, and long, dramatic tail feathers that are much desired by the native hunters. These birds are usually shy, but generations of Astrapias had learned that they could display in this sacred Araucaria grove without fear that they would be killed (Flannery 1998). Baptist missionaries worked to end what they called pagan beliefs and offered to purchase timber cut from this sacred grove; gradually they succeeded in ending the taboos. When Flannery visited the grove in 1992, a great fallen Araucaria lay near the path, its trunk hewn into segments with a chainsaw.

New Guinea's birds-of-paradise have been called the most spectacular birds in the world. They are confined to this island and its satellite islands, and extreme northern Queensland in Australia. Their dazzling plumage, showy courtship displays and haunting songs have inspired awe in all who see them. fiVoices in the Forest,fl a BBC film (see Video section, Birds), featuring these spectacular birds dramatically illustrates their conservation problems. Their feathers have been traditionally used for headdresses and costumes by natives, which has threatened some species. Commercial demand from outside the island for feathers, zoo and aviary birds and dried specimens poses additional threats to them. The entire family of these birds, Paradisaeidae, has been placed on CITES Appendix II to prevent illegal trade. Forest cutting poses an even more serious danger to birds-of-paradise populations. The majority of species inhabit primary rainforests, and many have extremely specialized habitat needs. As clearing continues, and logging roads open up more and more of New Guinea's forests, these birds lose their habitats and are more easily hunted. Four species of birds-of-paradise are listed as Vulnerable, and eight more as Near-threatened by BirdLife International; they comprise 28 percent of the 43 members of this avian family (BI 2000).

Less showy, but no less interesting, are New Guinea's bowerbirds. The constructions of bowerbirds are so elaborate that when explorers first encountered them, they were assumed to be man-made. Each species has variations on the construction, some building bowers with pass-through tunnels, others concentrating on accumulating a vast array of objects collected in piles of the same color to attract females. One very rare bowerbird, searched for in the wild on a dozen occasions, was finally found in the remote Foja Mountains by Dr. Jared M. Diamond of the University of California in 1979. This beautiful bird, the Golden-fronted Bowerbird (*Amblyornis flavifrons*), which may number only about 1,000 birds, is very restricted in range, limited to an area north of the Idenburg River between 1,000 and 2,000 meters (Beehler *et al.* 1986). The male of this species arranges sticks in a pile around a tree fern or sapling,

forming a tower up to 3.5 feet high on a circular moss platform with a raised rim. He clears the adjacent area of debris and places separate piles of blue, green and yellow fruits to attract the female. The blue fruit was also a newly discovered species. Making varied, loud calls even while holding a blue fruit in his beak, which contrasts boldly with his brilliant yellow head and back feathers, the Yellow-fronted Bowerbird perches near his elaborate bower performing for the drabber female.

An even more threatened bowerbird, Archbold's Bowerbird (*Archboldia papuensis*), ranges in the central mountain ranges of the island. The male has a long, forked tail and constructs a bower made of a large mat of ferns (Beehler *et al.* 1986). Inhabiting ancient *Nothofagus* beech forests, mixed with podocarps, bamboo and *Pandanus* at high altitudes between 2,300 and 2,900 meters, it has declined as a result of logging operations (BI 2000).

New Guinea's marsupials show great biological diversity, ranging from tree-kangaroos, an arboreal relative of the land kangaroos of Australia, to colorful cuscuses, tiny nocturnal possums and bandicoots. These fascinating mammals remained unknown to scientists until very recently as a result of the extremely rugged terrain, native tribes who were often unfriendly to outsiders, and the almost total lack of roads and other means of access. Many of these mammals are also secretive and nocturnal, hiding in the holes of giant trees covered in vines or inhabiting such restricted ranges that many have only recently been discovered after intensive searches in the wild. In 1865, for example, only 15 mammals had been named from New Guinea, and in 1875 that number had grown to 20 (Flannery 1995). By 1906, 126 mammals had been identified, including 50 marsupials and monotremes, but today it is known that at least 212 indigenous mammals inhabit New Guinea, many of which were discovered within the past decade (Flannery 1995). A surprising number of mammals inhabit a relatively small area and are threatened by forest loss and hunting.

Focus on Indonesia: Page 3

Thirty-eight marsupials and one monotreme (egg-laying mammal such as a platypus) are listed in the *2000 IUCN Red List Species*. One marsupial was previously unknown to scientists until 1994 when Tim Flannery (1998) discovered it in a remote mountainous area of Irian Jaya. This panda-like animal has long, fluffy black fur on its back and head, stripes of white on its belly and muzzle, and a white star on its forehead (see Flannery 1998 for color photo). It resembles no other tree-kangaroo and is also far more terrestrial than other species (Flannery 1998). The Moni tribe call it the "man of the forest," or Dingiso, because when threatened, it raises its arms above its head, exposing its white belly while letting out a whistle, which they consider a sign of recognition (Flannery 1998).

The Dingiso's scientific name, *Dendrolagus mbaiso*, means "forbidden" tree-kangaroo. The Moni believe it to be an ancestor and will not hunt it, but a neighboring tribe, the Dani, has no such taboo and kills the Dingisos for their fur, claws and tail tips. Weighing about 30 pounds and 30 inches tall, this fairly large tree-kangaroo lives in a dense, cloud pine forest up to 10,000 feet in altitude in the Maoke Mountain Range, an area where tree-kangaroos had never been seen. Within the territory of the Moni, this very tame tree-kangaroo is still common and can be easily approached by offering it some leaves; hunters take advantage of this trait by feeding it leaves and slipping a noose over its head (Flannery 1998). This beautiful animal is endangered, and should the protection of the Moni people end for some reason, it will likely become extinct, as it has already disappeared from the territory of the Dani tribe (Flannery 1998).

Focus on Indonesia: Page 4

Fig trees are among the most characteristic trees of Indonesia and other rainforests and are keystone species for wildlife. They are threatened by forest clearance and by loss of their seed dispersers. Some 800 species of fig trees

are found in tropical rainforests around the world. On Borneo alone, there are 140 species, 13 of which are endemic (Yates 1992). Among the tallest trees in these forests, they may attain a height of 150 feet. Strangler figs grow on the trunks of other trees, which they gradually kill by encircling them. All fig trees are dependent on wasps less than an inch long for pollination. (See "Borneo's Strangler Fig Trees," by Tim Laman in *National Geographic*, April 1997, which illustrates this pollination process in detail.)

A wide variety of birds and mammals feed on the abundant fig fruits, but few species actually disperse the seeds. Figs contain chemical compounds that have a laxative effect on the wildlife that eat them, a reproductive strategy designed to release seeds over a wide area. Animals as small as ants and as large as wild pigs, gibbons, and deer feed on the fruit (Laman 1997). Figs exist in such variety in unlogged, primary tropical forests that one species is always fruiting, supplying life-giving food to wildlife (Laman 1997). Hornbills may be more important than any other species in dispersing fig seeds because, rather than eating a portion of the fruit only, they eat the entire fruit, which is full of tiny fertile seeds, and then fly long distances, spreading the seeds in defecations. One ornithologist observed fruiting fig trees in Borneo with as many as 50 hornbills of eight species feeding together (Yates 1992).

Focus on Indonesia: Page 5

Hornbills also spread the seeds of other plants. In India, Great Pied Hornbills are vital to the dispersal of nutmeg seeds, since they are the only species with a beak large enough to open the seeds (Youth 1995). Ragupathy Kannan, a biologist studying this species in the Ghats region of southwestern India, discovered that the forestry department was intentionally cutting large fig trees in order to feed domestic Asian Elephants to haul lumber (Youth 1995). Kannan managed to convince them to ban fig tree cutting and, instead, to let Elephants browse freely in the forest (Youth 1995). If such conservation work took place throughout the ranges of hornbills, their future might be brighter.

The decline of hornbills throughout their Asian ranges highlights the loss of seed dispersers, as the forests themselves disappear or become logged over and fragmented. Hornbills are extraordinary birds, with their enormous beaks composed of horn-like material and, often, colorful facial markings. Some have a casque on top of the bill, giving the appearance of a double beak. The Rhinoceros Hornbill (*Buceros rhinoceros*), for example, has a typical downward-curving, white pointed beak, but atop it a bright orange-red casque curls upward at the tip like a rhinoceros horn. This species, native to Malaysia, Sumatra, Borneo and Java, has declined from trade and is listed on Appendix II of CITES. Averaging more than 4 feet long with 3-foot tails, hornbills make dramatic silhouettes as they fly over the forest canopy. Unfortunately, their size attracts hunters who kill them for sport or food, another factor in their rarity outside national parks. Their reproduction is highly unusual--unique, in fact--among birds. Courtship can involve spectacular head•on collisions between males, clashing their casques together. The hornbill pair, which mates for life, selects a nest hole high in a hollow tree, usually one that was created by a large limb falling off and the trunk area becoming rotted.

Since ideal nest sites are rare and found only in trees hundreds of years old, hornbills often use the same nest year after year. The female plasters the inside with droppings that harden, and the male plasters the outside, leaving a slit that effectively imprisons the female in the tree trunk hole for the next three months. She pokes her bill out to receive food from the male, who tips his beak into the female's open one and lets small round figs and other grape-sized fruits roll down. Other adults may help in feeding the chicks and female. Before the chicks are ready to fledge, the female breaks out and leaves the nest; the chick or chicks instinctively reseal themselves for another month, both parents continuing to feed them (Yates 1992). Finally, when ready, the chicks break out of the nest. It is thought that hornbills have evolved this method of reproduction to protect the female and young from tree•climbing predators, such as snakes and lizards. (The courtship behavior, nesting and feeding of the female and chick by the male Red-billed or Celebes Hornbill (*Penelopides exarhatus*) are beautifully photographed in the BBC film, fiCastaways of Sulawesi.fl See Video section.)

Hornbills, so important to fig trees and the host of species that feed on them, are themselves dependent on primary rainforest (Collins 1990). Their nest trees are often intentionally cut to obtain chicks for sale to zoos and in open wildlife markets. When these great trees crash down, they bring with them many adjoining trees, killing small mammals and birds in the process. The dual threats to hornbills of habitat loss and capture have resulted in dramatic declines in their populations. Should all the hornbill species that are threatened become extinct, the extinction of hundreds of other species may result, from the fig trees, whose seeds they spread, to many vertebrates and invertebrates. In 1980, only one species, the east Asian Helmeted Hornbill (*Buceros vigil*), was listed as Indeterminate by the International Council for Bird Preservation (ICBP) (now BirdLife International) as a result of killing to use their large casques for carving (King 1980). But by 1988, that organization listed seven Asian hornbills as threatened with extinction (Collar and Andrew 1988). In 2000, 18 of Asia's 30 species, or 60 percent, of hornbills were listed in *Threatened Birds of the World* (BI 2000). Seven of the 10 Philippine endemic hornbill species are threatened with extinction (BI 2000). The dramatic increase in threat to these keystone rainforest birds is a reflection of the destruction of Asia's rainforests.

Focus on Indonesia: Page 6

Other rare and declining inhabitants of Asia's rainforests play important roles in pollination. Many trees that produce important commercial products need to be pollinated by wild animals. An extremely valuable fruit is the Durian, which is almost unknown outside southeast Asia. In spite of a rank odor emanating from the outer fruit, the yellow core inside the rind is considered a great delicacy, worth more than $90 million a year in markets throughout Indonesia and Malaysia. What is less well known is the dependence of the Durian tree on a particular species of bat to pollinate it. The Cave Fruit Bat (*Eonycteris spelaea*) is the sole pollinator of these valuable trees, pollinating the flowers while feeding on the nectar of the flowering fruit. Yet this bat is unprotected from the persecution, hunting for food and destruction of its limestone caves that are causing its decline. The number of threatened bat species native to Asia has increased dramatically in recent years, according to the IUCN (Hilton-Taylor 2000). Throughout these rainforests, bats are disappearing, some before their ecological role was known.

Hundreds of tropical plants and trees have evolved for pollination by bats. Most flowers of such trees are found in the canopy, giving easy access to the nectar•feeding and fruit bats, either hanging on long stems, set clear of the surrounding foliage, or clustered on branch tips near twigs where bats can land (Mitchell 1986). These bat flowers open only at night, with odors quite unlike the day•blooming flowers that attract insects and birds; instead, they are musky and sour, which seem to attract the bats (Mitchell 1986). Evolved with shapes that conform to the muzzle of the bat in order to deposit pollen on the bat's face, some flowers have large, trumpet•like openings that almost engulf the bat's head. Others are brush•like with masses of stamens rich in pollen, while still others have numerous small flowers in a ball•like inflorescence producing both nectar and pollen (Mitchell 1986).

The trees that have evolved to be pollinated by bats, some even by a particular species of bat, while providing food for the bats, represent a classic example of mutual dependency. Current logging practices and the killing of many of these bats for food, or destruction of their caves, endanger both trees and bats. Many of Indonesia's threatened bats are fruit bats, and a large number are found only in Indonesia. The Pygmy Fruit Bat (*Aethalops alecto*), for example, is found only on Borneo; the Small•toothed Fruit Bat (*Neopteryx frosti*) is native to Sulawesi; the Javan Tail•less Fruit Bat (*Megaerops kusnotoi*) is restricted to Java; four others are confined to the island of New Guinea. Half of Borneo's 140 mammal species are bats, and more than 50 of these feed primarily on insects (Yates 1992), another major benefit of these poorly understood mammals.

Focus on Indonesia: Page 7

The threats to Indonesia's environment are strongly linked to the growth of its human populations. With the largest number of people on Sumatra, Java and Bali, lowland forests on these islands were cut for cities and farmland during the first half of the 20th century (Collins *et al.* 1991). Beginning in the 1960s, industrial, government-sponsored logging began on many islands for valuable timber. Uncontrolled logging and wildfires have consumed millions of acres for decades, destroying 44 percent of original habitats and nearly all the lowland rainforests in Indonesia (Mittermeier *et al.* 1999a). Java has become nearly denuded, due mainly to the massive growth in human population that totals more than 110 million, almost half the entire population of the United States (Mydans 1996a). The tiny satellite island of Bali has similar crowding problems, and very little forest remains. Between 65 and 80 percent of Sumatra's lowland forests have been cleared to make way for the ever-expanding human population (Collins *et al.* 1991). By June 2000, an estimated 224.8 million people inhabited Indonesia, the equivalent of 82 percent of the US population, living on 741,000 square miles, or 20 percent of the US land area (New York Times 2000).

Among the first casualties of this deforestation and population growth were Tigers, who numbered in the thousands on Sumatra, Java and Bali up until 1900. The populations of each island had been separated for at least 8,000 years (Matthiessen 2000), as each evolved into a separate race. The Javan (*Panthera tigris sondaica*) and Bali Tigers (*Panthera tigris balica*) were far smaller than other Tiger races, with males weighing only about 200 pounds, one•fourth the size of a male Siberian Tiger. Several Javan Tigers were kept in the Berlin Zoo in the early 1900s without any effort to breed them in captivity (see photo in Tilson and Christie 1999). After massive deforestation of these islands and heavy hunting pressure, their populations crashed (Simon and Geroudet 1970). Udjung Kulon, a large national park, was set aside for the Javan Tiger in 1921, but only 20 to 25 of the species survived by 1955, of which 10 were in this park (Simon and Geroudet 1970). By the 1970s, they had disappeared from Udjong Kulon, and only a few were left in Meru Betiri National Park in the far south. In 1980 a careful survey found tracks of at least three Javan Tigers, but there have been no signs since (Jackson 1990). Bali Tigers were once common in the western portion of the island, but not since 1952 has there been a confirmed report (Simon and Geroudet 1970). Both these races are now considered extinct in the wild, and none survives in zoos (Jackson 1990). These Tigers represented unique genetic strains that are now lost forever. They were the chief predators at the top of their food chain, and their loss impoverished these ecosystems.

The Sumatran Tiger (*Panthera tigris sumatrae*), the largest of the three, is the only surviving Indonesian Tiger. Highly endangered (Jackson 1990), its wild population may total only 500 or fewer animals (Nyhus *et al.* 1999). An intensive conservation program, begun in 1995, involves an international team of biologists who are attempting to determine just how many Tigers are left, whether they have sufficient prey species, how many are being killed by local people and the status of their habitat (Franklin *et al.* 1999). In Way Kambas National Park in the southeast, researchers, using cameras placed on trails, have photographed them. An estimated 36 Tigers inhabit the second-growth forest and degraded grassland habitat in this park of about 1,500 square kilometers. It is completely surrounded by villages, and nearly all its lowland primary rainforest has been cut (Franklin *et al.* 1999). Villagers resent the park's ban on using forest and grassland products, and when Tigers prey on livestock, often because of a lack of natural prey, the villagers put out poison. Sumatra's forest fires and rampant poaching of all large animals in Indonesia may extinguish the last of these Tigers, but the conservation research program intends to involve local villagers in saving the Sumatran Tiger and help address many of their needs in the process (Franklin *et al.* 1999). This race of Tiger is kept in many zoos around the world, unlike the Bali and Java Tigers, and has reproduced. The fragmentation of the forest range of Tigers throughout Asia to India has isolated populations, caused inbreeding, and exposed them to poaching, even in national parks.

The parks created for the Javan and Bali Tigers protect a great diversity of other wildlife and plants. Meru Betiri

National Park preserves the last remnants of lowland rainforest in Java (Whitten and Whitten 1992). A population of about 75 to 100 endangered wild cattle, or Banteng (*Bos javanicus*), and Leopards (*Panthera pardus*) are also resident (Whitten and Whitten 1992). Unfortunately, illegal cutting of trees and rattan within the Meru Betiri National Park has been extremely destructive (Whitten and Whitten 1992). Udjung Kulon National Park on the western tip of Java is home to a small population of Javan Rhinoceros (*Rhinoceros sondaicus*), the rarest of all rhinoceros, along with Sambar Deer (*Cervus unicolor*) and Barking Deer (*Muntiacus muntjak*) and Banteng (Whitten and Whitten 1992). Sumatra has several important national parks as well. Mount Leuser National Park's swamp forests protect the last Sumatran Rhinoceros (*Dicerorhinus sumatrensis*), second rarest of the rhinos. This extremely primitive and hairy rhinoceros has been captured for zoos, where most have died and none has been born in captivity. Researchers in the park have tried to prevent further captures of these highly aquatic rhinos in order to preserve the last wild members of the species. This park also has resident Orangutans (*Pongo pygmaeus*), Siamangs (*Hylobates syndactylus*) and endangered Sun Bears (*Helarctos malayanus*). Unfortunately, some of Sumatra's national parks have been overrun with people cutting trees, causing erosion, and replacing forest with agriculture. The Kerinci-Seblat National Park, located along a mountain range in southern Sumatra, encompasses 14,847 square kilometers of forest, but within the park is a virtual city of 273,000 people, growing at a rate of 3.6 percent a year, who denude the hillsides and convert forest to cinnamon, cloves and coffee. They are gradually destroying this entire forest and the watersheds of the island's two most important rivers (Collins *et al.* 1991).

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Until about 30 years ago, Borneo had extensive, unspoiled and magnificent forests. The third largest island in the world after Greenland and New Guinea, it covers 215,000 square miles (Smythies 1960). Prior to recent logging and forest fires, it was described as "one enormous forest" by Bertram E. Smythies, author of *The Birds of Borneo* (1960); 75 percent of the island was primary forest, and 10 to 15 percent, secondary forest (Smythies 1960). Mangrove forests grew abundantly along the southern and southeastern coasts, extending far inland, lining major rivers and blending into vast swamp•forests (Yates 1992).

By the late 1970s, an estimated 66 million acres of the country's forests had been classified as denuded (Allen 1980). Forest clearance on Borneo and in Sumatra took a dramatic turn in the early 1980s when landowners and settlers set fire to forests felled for commercial timber, palm oil and tree plantations and homesteads to destroy stumps and brush. This was done in spite of a law banning the setting of fires. The largest forest fire ever recorded on Earth took place in the old-growth forests of Borneo during 1982-83 and lasted for 18 months (Collins *et al.* 1991). More than 9 million acres, or 33,000 square kilometers, were destroyed in east Kalimantan, including 8,000 square kilometers of unlogged dryland primary rainforest and 5,500 square kilometers of peat swamp forest; the rest was selectively logged forest and settlement areas (Collins *et al.* 1991). This was the first time that living rainforest had been seen to burn. Half the new Kutai National Park was destroyed, and another 2.5 million acres burned in Sabah in the northwest of Borneo (Yates 1992). Wildlife was seriously affected, and some burned land was later converted to tree plantations (Collins *et al.* 1991).

During the 1990s, more fires erupted, spreading to adjoining forests. Logging practices involved the removal of the largest trees, leaving leaf litter, small trees and broken branches that dry out (Paul 1998). The logging opened up the canopy, allowing further drying-out of the forest floor, and humidity dropped (Paul 1998). Fires set in clearcuts entered logged rainforest through these logging openings, setting the entire forest afire (Paul 1998). In 1991, another 190 square miles of East Kalimantan burned, and in 1995, massive fires broke out in Kalimantan and Sumtra (Paul 1998). Two years later, an estimated 750,000 to 1.5 million acres of forest burned in Sumatra and Kalimantan (Howe 1997), including a devastating fire in Tanjung Puting National Park, a prime refuge for Orangutans (Paul 1998). So immense were these wildfires that the smoke spread to neighboring countries, causing severe air pollution in cities and towns, and the fires were seen clearly from satellites orbiting the Earth. A Canadian observer from a vessel in the

China Sea during these fires wrote to *National Geographic* (December 1998): "Even at 250 kilometers [155 miles] distance from the coast of Kalimantan, the air was thick with smoke. For nearly three weeks we could not see the sun's disk, only smoke-diffused light. The most astonishing and sad event we witnessed happened one night when we were surveying . . . Our ship was engulfed by an ever increasing flock of exhausted birds and bats, all fleeing the fires of Sumatra. Dozens of birds landed all over the deck, where, too fatigued to move, they could easily be approached and handled. In the morning we found several tired bats dangling from overhead steel gratings. I sincerely hope that a new and more benign Indonesian government will prevent such awful, and needless, environmental calamities from happening again" (Christopher Woodworth).

In Borneo and Sumatra alone, 14.8 million acres are estimated to have been destroyed prior to 1998, still charred and black years afterward (Paul 1998). A zoology student and his girlfriend traveled across Kalimantan in the late 1990s, seeing no green except along roads--small farms and banana trees (Paul 1998). In parts of the region, underground fires burn for years, igniting deep beds of peat and coal seams. The Indonesian government's reforestation funds were rerouted, first by President Suharto, then by his successor, President Habibie, to develop industrial oil palm and timber estates (Paul 1998).

After worldwide publicity and protests from other countries about the fires, and condemnation of Indonesia's failure to act against those responsible, in early October 1997, the government revoked the operating permits of 29 companies that had set illegal fires. This had little effect on fire-setting, as more fires broke out in the following year. In 1998, another million acres burned, and in 1999, an area the size of Vermont and New Hampshire burned on Borneo. In the summer of 2000, smoke from Indonesia's illegal forest fires again blanketed nearby Malaysia's capital, Kuala Lumpur, and Singapore (Mydans 2000). After the fires, floods made the forest loss in Kalimantan permanent by washing away soil, leaf litter and nutrients from the fires ashes (Kaplan and Rogers 2000). Exotic Imperata grasses took hold in many areas, poisoning the ground with substances that inhibit the growth of trees, signaling the end of the rainforest (Kaplan and Rogers 2000). Some 80 percent of the forests in the southeast of Borneo are now gone.

During these fires, wildlife, including such critically endangered species as Sumatran Tigers, Orangutans (*Pongo pygmaeus*) and Asian Elephants (*Elaphus maximus*), fled the fires into villages, where many were killed or captured for sale as meat or pets. Stephanie Fried, a scientist with the Environmental Defense Fund in Washington, DC, who has studied the timber trade in Indonesia, described these fires as the result of "appalling forestry practices and rapacious greed" (Howe 1997).

The fires destroyed most of Borneo's lowland rainforests, where 267 of the world's 600 dipterocarp trees, or trees with "two•winged fruits," dominate; 150 of these exist nowhere else (Whitten and Whitten 1992). This family of trees, Dipterocarpaceae, has species from the Seychelles to New Guinea, but Borneo has by far the most species (Whitten and Whitten 1992). Many reach heights of 250 feet or more and are pollinated by tiny thrip insects. They are extremely important to wildlife, producing fruits, flowers and digestible leaves that are fed on by birds, gibbons and a variety of other animals (Whitten and Whitten 1992). Each year, 2,500 square kilometers of dipterocarp forest are logged in Sarawak, and these old-growth forests are often replaced with tree plantations (Collins *et al.* 1991). Elsewhere in Indonesia, these are the preferred trees to be logged, with their unbranched, wide trunks used in furniture, plywood, resins and camphor (Whitten and Whitten 1992). It was almost inevitable that many of these trees became extinct. The *1997 IUCN Red List Plants* lists a dipterocarp trees native to west Sumatra as Extinct. Another species is extinct on Sumatra but still survives in Peninsular Malaysia, along with 95 other members of the family listed as Threatened or Extinct on the island of Borneo and the rest of Indonesia. Four species of the giant kauri *Agathis* that grow in Borneo's higher altitude forests are also threatened with extinction (Walter and Gillett 1998).

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Orangutans once ranged in mainland southeast Asia as well as Indonesia, but hunting and forest cutting eliminated them from 98 percent of their original territory, leaving populations only on Sumatra and Borneo. These islands were home to tens of thousands of Orangutans at the turn of the century, but since then, these intelligent apes have been pushed into pockets of shrinking rainforest. Orangutans are unable to adjust to second-growth forest and depend on very large ranges within primary rainforest, where they feed on ripe fruit and flowers. Their populations have become scattered from loss of old-growth forest, and even national parks are no longer safe havens for them, as poaching and illegal logging increased in the late 1990s. Orangutan populations decline between 60 percent and 95 percent in selectively logged forests (Newman *et al.* 2000). The logging scares them out of their territories, and they often die of starvation or accidents (Newman *et al*. 2000).

One of their former strongholds was the Tanjung Puting National Park, 741,000 acres on a peninsula on the south coast of Borneo. It was upgraded to national park status in 1982, primarily to protect the Orangutan. This is the largest swamp forest in southeast Asia, with a mosaic of habitats, including primary rainforests. The Environmental Investigation Agency (EIA) of London conducted an in-depth study of illegal logging in this park, publishing a report, *The Final Cut*, in 1999 (Newman *et al.* 1999). Illegal loggers were so blatant that they built a wooden railway to slide out the giant logs. When government officials were notified, they did nothing, as they had apparently been corrupted by bribes from the loggers (Newman *et al*. 1999). In December 1999, biologists in the park found themselves ordered by armed loggers to leave. Similar illegal logging took place in other parks and reserves crucial to the survival of the Orangutan, leaving few areas not seriously degraded (Newman *et al*. 1999). EIA turned over to Indonesian government authorities, including the Governor of the Province, copies of its detailed report on illegal logging, which had uncovered the fact that 70 percent of the timber being processed in Indonesia came from illegal logging (Newman *et al*. 2000).

The World Bank in Jakarta estimated that between 1985 and 1997, Indonesia lost an average of 1.5 million hectares of forest cover every year, with dry tropical forest, an endangered ecosystem, suffering the greatest losses. Sulawesi has been logged out, and this forest type could disappear from Sumatra and Kalimantan in the near future (Newman *et al.* 2000). Logging supplies 2 million cubic meters of timber to its many pulp mills (Mittermeier *et al.* 1999a). The lack of strong government control has allowed corrupt timber barons to emerge and control the rampant illegal logging that is leaving little of the country untouched (Newman *et al.* 2000). In spite of international publicity about this disastrous state of affairs, and pressure from international donor agencies, the Indonesian Government stated that it would stop the illegal logging, but did not take action. The bribery scandal apparently reaches into high levels within the government (Newman *et al.* 2000). In May 2000, student activists, frustrated by the government complicity in the looting of their national heritage, held four government officials at a port in West Kalimantan after Customs and other officials failed to halt the shipment of an illegal consignment of timber to Singapore. This shipment, with 70 containers of logs, was forced to return to port and its cargo seized (Newman *et al.* 2000). China and the European Union import more than half the timber exported from Indonesia, and to date, no action has taken place by importing countries to confiscate illegal shipments of timber (Newman *et al.* 2000).

The status of Orangutans has gone from endangered to critical. Decades of logging, clearing and forest fires have destroyed the majority of their primary, old-growth forests on Borneo and Sumatra. Thousands were killed during these fires and hundreds that fled burning forests and entered open areas near villages were killed by villagers wielding machetes. Mothers were hacked to death to obtain their babies, who were often wounded in the process. Hundreds of orphaned Orangutans, pitiful, sickly and malnourished, were confiscated during this period and placed in rehabilitation centers. Many died, and the traumatized survivors clung to one another in crowded pens and crates, mass fed by volunteers and workers of these centers. The Leakey Research and Rehabilitation Center for Orangutans in southern Borneo, and two other centers on the island, have cared for hundreds of these orphans. In 1997, the Wanariset Orangutan Reintroduction Project in East Kalimantan received 118 baby Orangutans, and in 1998, 60 more arrived (Paul 1998). In August, 1998, the station held 171 refugee and injured Orangutans, most very young (Kaplan and Rogers 2000). Many mother Orangutans died of starvation, trying to sustain themselves on acacia bark, and their young were so weak they could hold on no longer and fell to the ground. Some mothers were eaten by the starving

local people, and others succumbed to disease (Kaplan and Rogers 2000). Even those saved and rehabilitated have a low rate of survival. Fewer than half survive in the wild, according to Martinus de Kam, site manager of the Wanariset Forestry Research Project (Paul 1998).

Birute Galdikas, a renowned primatologist and the world's foremost expert on the species, runs the Leakey center and was almost overwhelmed by the numbers of orphans to care for. Moreover, quite a few Orangutans that had been rehabilitated over the past decade and returned to the rainforest came back to the Leakey center for food as their forests were burned or fruit trees cut. In the early 1990s, Orangutan populations were estimated at more than 22,000, with 9,200 on Sumatra and up to 15,546 on Borneo (Nowak 1999). Few believe that more than 15,000 survived the forest destruction and fires of the late 20th century. Galdikas has stated that the species may be doomed to extinction, left with too little habitat to survive. Two primatologists, Gisela Kaplan and Lesley J. Rogers (2000), who have studied Orangutans for many years, conclude that these fires may have been enough to set the final scene for their extinction in Borneo before too many years. Wild populations are unable to sustain the removal of so many female Orangutans. Their reproduction is among the slowest of any mammal. Males are solitary, and females live with their single young for eight to nine years before having another baby (Kuznik 1997). A loss rate of only five Orangutan females out of 1,000 per year can cause a stable population to decline, according to Mark Leighton, a Harvard ecologist conducting research in Borneo's rainforests (Kaplan and Rogers 2000). This rate was surpassed many times during the 1990s. This picture has been further complicated by the recent genetic analysis of Orangutan DNA, which has revealed that there are two, not one species: the Sumatran has been renamed (*Pongo abelii*) and the Bornean retains the original scientific name, *Pongo pygmaeus*. These two primates have been long separated from one another and developed changes in their genes that warrant separating them as species (Kaplan and Rogers 2000; Hilton-Taylor 2000). There are physical differences as well. The Bornean Orangutan is far larger than the Sumatran, perhaps because it has not had to be agile to flee from Tigers, since the species is absent on Borneo. Both species are listed in the *2000 IUCN Red List Species*, the Sumatran as Critical and the Bornean as Endangered.

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Many islands, including Borneo (Kalimantan), Sulawesi and western New Guinea have had to absorb millions of people relocated from overpopulated Java under a government program. Beginning in 1978 with partial funding from the World Bank, more than 100,000 people per year were relocated to these and other out-islands costing $2 billion by 1992 (Durrell 1992). By 1996, 6 million people had been relocated from Java; Sumatra received the greatest number of people, followed by Kalimantan, Sulawesi and Irian Jaya (Mydans 1996a).

Irian Jaya™s 350,000 square kilometers of forests are still largely intact, but they are rapidly being destroyed by settlers. More than 250,000 people have been sent here, pushing aside the native New Guinea tribes who have witnessed their pristine rainforests cleared, even on steep slopes, for subsistence farming (O'Neill 1996). One tribesman said, "While we believe we are descended from the forest, most Indonesians believe that devils live in the forest and that the forest must be destroyed" (O'Neill 1996). The Indonesian government clearcuts 5 acres of forest for each family and supplies tin shacks, seeds and tools (O'Neill 1996); these shacks are lined up in rows on the remnants of the rainforest that once rang with the calls of birds-of-paradise. Villagers are encouraged to cut trees and are paid $1.30 for each tree by the government (O'Neill 1996). Roads, schools, clinics and other modernizations are planned, and towns of up to 250,000 people are being carved out of the virgin rainforest (Flannery 1998). New Guinea tribespeople are resentful about the forest cutting and have documented many instances of killing and cruel treatment they have received from the Indonesian military (Flannery 1998). They believe that Indonesia has invaded their lands, and they have organized a resistance movement, demanding that the land be returned to them (Flannery 1998).

The relocation program has been a dismal failure, not only for the people who were unable to farm the thin,

infertile soil of cleared rainforests, but for the devastated environment and wildlife (Durrell 1992, Flannery 1998). The rainforest is not the only ecosystem that has been destroyed by these settlers. On heath and sandstone ridges on Borneo, stands of Ironwood (*Eusideroxylon zwangeri*) grow. These are very unusual trees for tropical areas (Mittermeier *et al.* 1999a). Many of the Javan immigrants are unhappy with the conditions of their new lives and return home (Mydans 1996a). Irian Jaya is expected to remain a center for relocation, however, since only 4 million people live here, and the giant Freeport mine that has removed entire forests employs large numbers of people who come from abroad to work in the mines, living in air-conditioned, newly built homes. Family planning over the past decade reduced the rate of growth on Java from 2.1 percent to 1.5 percent, or half a million fewer births every year (Durrell 1992), but an influx of as many as 1 million people a year still flood into Java from elsewhere in Indonesia and Southeast Asia (Mydans 1996a). Had Indonesia devoted more of its financial resources to family planning a generation ago, as did Singapore, which now has a stable population with a low birth rate, the highly expensive relocation program would not even have been considered.

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The future of Indonesia's forests and their wildlife may be as bleak as that of other tropical forests in the Philippines, Thailand, West Africa and many parts of Latin America and the Caribbean. The disappearance and endangerment of large, wide-ranging mammals, followed by fragmentation and loss of the fauna and flora of entire regions, is a pattern that is being repeated here. The government has set aside many national parks, but as in other parts of the world, they are rarely given a high priority for protection, and local people are allowed to log and even establish agriculture plantings and villages within them. The native tribes of Papua and Kalimantan may force a change in the attitude of the government toward the forests and even end in a return of the land to the people who have lived there for thousands of years and have a strong bond with the native trees and animals. Violence has broken out between natives and immigrants on both islands, leading to the forced departure of hundreds of people in Kalimantan after many were killed by Dyak tribesmen in 2001. In Papua New Guinea, international rainforest organizations have become allied with native tribes in fighting corporate loggers from Australia, and they have been successful in taking legal actions that negated corrupt agreements made between their own leaders and the loggers.

The potential for ecotourism in Indonesia is great. The islands are already a major draw for tourists, spending more than $1 billion per year. A powerful movement for democracy is making strides in the country, and with more help from the United States and other democracies of the world, this would become a reality. With a radical change in Indonesia's government, priorities might change to benefit the Indonesian people and their environment instead of making the rich richer at the expense of biodiversity. If that happened, more and more people would learn the value of preserving forests and the country's extraordinary biodiversity for their own benefit as well as that of the entire world. The thin, tropical soils of the country have proven to be best for growing trees, and when this is better appreciated, the tide may turn.

Strong and immediate action is required, however, to prevent biological diversity losses that will dwarf those of any other area on Earth. Stabilizing the human population would be a major step in the right direction. By 2025, it is projected that Indonesia's population will exceed 275 million (Mittermeier *et al.* 1999a). If the government does not stop the disastrous and unsuccessful resettlement program, there will be no wilderness forests left, and the remotest national parks will be invaded for tree and rattan cutting and other destructive uses that will inevitably cause massive animal and plant extinctions.

The participation of international conservation organizations in programs to educate Indonesians to live in harmony with nature and to protect biodiversity is in its early stages. Several of these groups have helped produce field guides, books, posters, pamphlets and textbooks, and the series *Ecology of Indonesia*, in Indonesian (Mittermeier *et al.* 1999a). Protected areas total about 110,000 square kilometers, and the important work of protecting them from

encroachment and destruction is being aided by projects such as The Nature Conservancy (TNC) work in a huge, 231,000-hectare national park in southern Sulawesi, Lore Lindu National Park (Mittermeier *et al.* 1999a). In cooperation with the government conservation agency and local groups, TNC is conducting a comprehensive education program that also encourages butterfly farming and ecotourism to stem forest clearing and rattan collection (Mittermeier *et al.* 1999a). Other programs to encourage ecotourism and create sustainable models for local economies have been launched. In some cases, international programs have failed. In the 1980s, the World Bank funded a program to protect a 300,000-hectare national park in northern Sulawesi and help local farmers irrigate rice fields while protecting the watershed. These worked at first, but enforcement lagged and gold miners have entered the park and poisoned rivers with mercury. Forest clearing, hunting and rattan collection have also occurred within the park (Mittermeier *et al.* 1999a). Emergency programs to stop incursions into national parks are needed.

A new and potentially major source of income to benefit wildlife and the environment involves the placement of videocameras connected to the Internet in wilderness areas. These cameras can be solar-powered and placed in tree tops, animal dens, waterfalls or other attractions. Such videocameras, using satellites to beam live pictures or web pages to Internet users around the world for a small fee, are helping to finance the conservation work of national parks in South Africa and Central America. Internet users have increased exponentially in the past decade and are expected to continue to grow in number. Many "surf" the Internet for amusement, while others seek wilderness views or natural history information. If the funds were managed so as to be devoted entirely to protection of the environment and related programs, many millions of dollars could accrue. A conservation organization could publicize the fate of a particular species, group of species or region to raise funds for its protection. Certainly Indonesia has hundreds of appealing animals. Orangutans, Sumatran Tigers, Proboscis Monkeys, gibbons, Babirusa, tiny deer, cockatoos and parrots (some as small as sparrows), birds-of-paradise, bower birds and Komodo Dragons are among animals that could appeal to millions of people around the world. Spectacular and magnificent coral reefs, ancient forests, giant flowers, carnivorous plants, mangroves and wild rivers could also be filmed for the Internet. An Internet site could have biodiversity data for students and the general public and lists of projects that need financial aid. Ecotourism opportunities could also be part of this site.

On behalf of American consumers and those in Japan and countries importing plywood and concrete forms from Indonesia, conservationists could approach importers, building companies, stores and builders to propose substitutes. In many cases, users of these products have little idea where they came from or the effect their purchase has on forests half a world away. The key to saving Indonesia's wild heritage lies in making it more profitable to conserve it than destroy it, and educating these already highly literate people to preserve their own future in the process.

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Endangered Species Handbook

Grasslands, Shrublands and Deserts:

Grasslands, Shrublands, Deserts

Introduction

Providing splendid scenic vistas, grassland, shrubland and desert environments cover two-thirds of the world's land surface. The greatest diversity of grazing animals on the planet calls these open habitats their home, and they are preyed on by a variety of wild cats, dogs, wolves and hyenas. Grassland habitats appeared on Earth some 70 or 80 million years ago, following the extinctions of the dinosaurs. As flowering plants, grasses grow in great concentrations in semi-arid climates Œ where, as a general rule, annual rainfall ranges between 10 and 39 inches (Brown 1985). The root systems of perennial grasses and forbs form complex mats that hold the soil in place. Mites, insect larvae, nematodes and earthworms inhabit deep soil, which can reach 20 feet underground. These invertebrates, along with symbiotic fungi, extend the root systems, break apart hard soil, enrich it with urea and other natural fertilizers, trap minerals and water and promote growth (Chadwick 1995). Some types of fungi make the plants more resistant to insect and microbial attacks.

Among the various grasses grow many kinds of wildflowers, succulent plants and other non-woody species. On savannahs, trees and small woodlands are scattered in the grasslands. Flowers brighten grasslands in annual splashes of dazzling colors. An array of gentians, poppies, wild tulips, irises, orchids, bluebells, daisies, asters and myriad other flowers bursts into bloom each year, creating a brilliant montage against the green of new grasses.

A great diversity of insects, including colorful butterflies and tiny bees, pollinate these plants. Their seeds are dispersed by the wind, as well as by birds and mammals. Natural grasslands are the ideal habitat for herds of hoofed animals who fertilize the soil with their dung, which is later broken into nutrients by a host of invertebrates, fungi and microbes. Rodents and other burrowing animals excavate holes and chambers that feature complex side passages and multiple entrances, providing escape routes, birth chambers and sleeping areas. Other animals, including snakes, tortoises and ferrets, use the burrows as their habitat. Natural grasslands are intricate webs of animal, plant and fungal communities, and much remains to be learned about their functions.

Ecologists divide grasslands into two major types: tropical and temperate. Temperate grasslands tend to grow in the rain shadow of mountain ranges (Simon 1995). The Central Asia steppe Œ a treeless plain Œ has a low rainfall because the Himalayas and other mountain ranges block humid winds. The Rocky Mountains impede Pacific winds that bring rainfall from the North American prairies. Winters in temperate grasslands are usually severe, with freezing temperatures and howling winds. While temperate perennial grasses regenerate from dormancy each spring by sprouting from their roots, grasses in the tropics do not enter a dormancy period and instead grow year-round. Tropical grasslands tend to be located between forests and deserts (Simon 1995). Climate in the latter type of grassland is generally mild, and most have seasonal dry and wet seasons, each lasting about half the year. In some environments, especially those bordering on shrub or desert, temperatures can rise to searing heights in the dry season, drying up natural ponds and streams.

Some grassland is in areas of high rainfall, but other conditions prevail that inhibit the establishment of trees and forest, such as shallow soil that prevents trees from taking root, or stony, nutrient-poor soil. The presence of large numbers of ungulates who crop the grasses also prevents trees from taking over the land. The Serengeti and other East African grasslands would soon become acacia woodland if not for the presence of millions of wildebeests and other ungulates. Fires, either ignited by natural lightning or set by people, and mowing also maintain grassland by removing young trees and shrubs. Grasslands and related habitats tend to grow in areas where forests have been cut and rich top soil has washed away; the moors of the British Isles, for example, are composed of heath, grasses and ground plants that replaced the forests cut centuries ago, following erosion of the topsoil (Simon 1995).

During the Pleistocene, 100,000 to 10,000 years ago, rich grasslands with thick topsoil covered millions of square

miles in Africa, Australia, Asia, South and North America. They supported an unparalleled diversity of large mammals. Sabre-toothed and huge lion-toothed cats, dire wolves, cheetahs, hyenas and bears preyed on herds of bison, deer, mastodon, mammoth, camel, rhinoceros, antelope, wild horses and gazelles on North America's rich grasslands. In Australia, giant marsupials were the predators of large kangaroos and wallabies. Outside Africa, almost all these wild species disappeared by the end of the Pleistocene, concurrent with heavy hunting by native peoples. Some large mammals survived, however, and in many areas great herds grazed the grasslands in untold millions until recent times. In these natural grasslands, each large mammal consumed a slightly different type of vegetation, whether new grass, forbs, mature grass or other plants, allowing many species to coexist without damaging or overgrazing the environment. Today, grasslands, shrub and mixtures of these habitats cover about one-fourth of the Earth's surface.

Shrubland ecosystems, characterized by bushes, shrubs and scattered trees, require very little water. This habitat is often degenerated woodland or grassland, as seen in many parts of coastal Greece and the Near East where topsoil has eroded. Desert and shrub habitats in Mediterranean countries are the product of thousands of years of abuse of the land, beginning with forest clearance for grazing and agriculture. Shrubland quickly turns to desert when desecrated by brush clearance or heavy livestock grazing. In some parts of the world, shrubland is a natural habitat; many species of birds, mammals, reptiles and invertebrates have evolved to adapt to live in such an environment.

Deserts, which cover almost 40 percent of the Earth's surface (Allan and Warren 1993), receive less than 10 inches of rain a year (MacMahan 1985). Within these ecosystems, the annual rainfall limits the types of vegetation able to survive. Arid zones receive less than 8 inches of rain per year, while in hyper-arid zones, less than an inch of rain falls per year (Allan and Warren 1993). Rainfall in deserts tends to be unpredictable. In some deserts, no rain falls for several years, followed by a series of torrential storms in one season. Desert life has evolved remarkable adaptations to these conditions. Many plants have leathery, water-retentive leaves or spongy trunks for storing water, and seeds that can remain dormant in the soil for many decades. A few species of desert animals never drink, only obtaining water from plants they eat. Desert toads can remain in a torpor underground for years until a rainstorm awakens them.

The Sonoran Desert of the southwestern United States and northern Mexico is the lushest and most botanically rich of all deserts, with 2,500 species of plants, 300 of which are cactuses. A fairly mild climate provides habitat for deer, peccaries, pronghorn antelopes (*Antilocapra antilocapra*), bighorn sheep (*Ovis canadensis*), various cat and canine predators, tortoises and many types of birds, snakes and lizards. In contrast, very little vegetation grows in the Sahara, where thousands of miles of sand stretch to the horizon. The Atacama Desert of Chile has the lowest rainfall of any desert in the world, and relatively few wildlife species are able to survive. Its temperature falls rapidly from searing hot during the day to freezing at
night. Desert animals have adapted to these extremes by living in burrows that insulate them from the heat and cold.

Benefits of Drylands

Grasslands have great biological diversity and stability; they are able to resist plant disease and drought. As such, they represent invaluable genetic banks. This diversity is being studied by scientists around the world and consequently uncovering chemical and biological secrets. Agriculture and other food production will profit from this emerging knowledge.

Wheat, corn, oats, barley and rye Œ the bases of most human diets Œ are domesticated types of grasses bred from wild plants. No longer perennial, they must be planted each year and have become extremely vulnerable to disease,

insect predation and drought. They are grown in monocultures, fields of a single species that often have insect pests or diseases sweeping through them. Moreover, soil that is artificially fertilized and sprayed with pesticides and herbicides lacks the millions of invertebrates, fungi and other creatures that make wild grassland soil rich and resistant to insect pests and disease. Wild plant genes have proven valuable in producing hardier varieties of domestic strains through cross-breeding (Chadwick 1995).

Many perennial wild plants have the potential to become food plants because of their natural resistance to insects and drought. These grains would not have to be replanted each year, which is a great benefit because plowing causes erosion and requires great amounts of energy. Maize, a type of corn closer to wild strains, is a major food source in Latin America and elsewhere. It is one of the most photosynthetically efficient grain crops in the world, able to transform the sun's energy into food very effectively (Viola and Margolis 1991). Grown in North America and Europe mainly as livestock fodder, it has great potential as a human food source. The Land Institute of Salina, Kansas, is working to discover new perennial grasses that might be sources of food (Chadwick 1995). Eastern gama grass, for example, native to the American prairie, needs far less water than conventional crops (Chadwick 1995).

Native peoples have traditionally utilized a wide variety of wild grassland and dryland plant seeds for food and other purposes, and many of these plants represent potential food sources. Another dryland plant native to the Americas and a staple food crop, the potato, has wild ancestor species that contain natural insecticides. Certain varieties of potatoes produce high levels of bitter, toxic glycoalkaloids, which make plants insect-resistant; native peoples of the Andes have long removed these toxins by cooking the potatoes with clay (Viola and Margolis 1991). Domestic strains of potatoes are prone to disease, most tragically illustrated by the 19th century famine in Ireland it caused.

Rainforest plants have been studied by scientists and pharmacological researchers for their medicinal value over the past few decades, but many grassland plants have been used for centuries by native peoples to treat various ailments. Extracts of the purple coneflower (*Echinacea purpurea*), for example, native to tallgrass prairies of America, have been found to be an effective treatment for symptoms of colds; they marketed as Echinacea in health food stores and pharmacies in the United States. This plant was used by Native Americans for many medicinal purposes (Madson 1993), and compounds within it have been found to kill insects (Chadwick 1995). So popular is this plant that many collectors have threatened the species by pillaging the last scraps of native grassland to dig up wild specimens that are reputed to have greater potency than cultivated plants**.**

Another plant being commercially marketed for its health effects is goldenseal (*Hydrastis canadensis*), a species of the buttercup family found in grasslands throughout eastern North America. Native Americans used it as a tonic, an astringent and an insect repellent, as well as a yellow dye. It is considered rare because its roots were overcollected (Niering and Olmstead 1979). Blue (great) lobelia (*Lobelia siphilitica*), a wildflower of eastern North America, was given its scientific name based on its supposed ability to cure syphilis. While not effective against syphilis**,** its root contains alkaloids that cause vomiting (Niering and Olmstead 1979). Other American grassland plants used for medicinal purposes include feverwort (boneset), prickly poppies, prairie larkspur, western ragweed and prairie goldenrod (Chadwick 1995). A type of prairie nematode is being tested as a possible cure for Alzheimer's and other neuro-degenerative diseases (Chadwick 1995).

American grasslands and shrub also home to Sassafras (*Sassafras albidum*) and Sarsaparilla (*Aralia nudicaulis*), from which medicinal teas, beverages and infusions are made. Wild plants of the Cactus family have been used traditionally by Native Americans and Mexicans for food, medicine and beverages. Some species, such as cactuses and baobabs, store water in their stems or trunks. Aloes of many species in North America and Africa have been found effective in treating burns.

Researchers seeking new treatments for human kidney problems are studying desert animals who recycle their own urine. Should the physiology of this phenomenon be discovered, it might be applied to kidney patients to prevent the need for dialysis. Deserts abound with poisonous snakes and lizards, whose venom has already proven to be

medically important as pain killers and for other purposes.

Many wild species that have endured the extremes of weather for eons and have traits that might be of great value to humans are in danger of disappearing altogether as humans take over their habitats for agriculture and development. Without conservation, they may disappear prior to discovery of their benefits.

Destruction of Drylands

Humans began adversely affecting natural grasslands some 50,000 years ago with the introduction of livestock. Herders set fires to grassland to maintain it for grazing, but frequent fires caused deterioration of these ecosystems and eliminated many native species of wildlife that could not adapt. To protect their livestock, herders killed off competing wild ungulates and persecuted predators and rodents, contributing to the decline of natural grassland ecosystems.

As livestock gradually replaced wild ungulates, grasslands around the world turned to shrub and desert. Millions of cattle, sheep, goats, domestic camels and yaks have come to dominate the ecology of grasslands wherever they exist, often eliminating native species of wild perennial grasses that anchored the soil with their extensive root systems. In their place, annual plants and exotic species of grasses now dominate many grassland environments. Domestic goats may be the worst offenders; they pull grass out by the roots, damage shrubs and trees by stripping them of all vegetation and climb low trees to graze. Once the vegetation has been stripped and the roots are removed, wind blows the topsoil away or rain carries it off.

When livestock is removed, grasslands may be able to recover if the damage is not too severe. But plowing, especially by modern deep plows, obliterates all vegetation, including dormant seeds, and wildlife. Natural grassland and shrubland are fast disappearing under the plow, endangering a growing number of plants and animals. Chemical fertilizers do not nourish the soil as well as natural invertebrates, decayed vegetation and animal dung. Unlike the soil in natural grasslands, chemically fertilized soil easily becomes hard and impermeable. The result is less productive soil that requires the use of more and more synthetic fertilizers each year to produce the same size crop. Because artificial fertilizers do not contain natural micronutrients, crops grown using them may be nutritionally deficient. Moreover, fertilizer nitrates that enter the water have produced algal growths in rivers and coastal regions that are so dense they choke out all forms of life, leaving "dead zones."

Many agricultural crops, especially those grown in arid regions**,** require artificial irrigation. Sources include underground reservoirs, fed by rainwater that fell thousands of years ago, that underlie many deserts and shrublands. Known as fossil aquifers, they have recently been exploited through deep wells and are rapidly becoming depleted in portions of the Sahara, Namibia, Saudi Arabia and the United States. The aquifer beneath the Great Sand Desert of Iran has been pumped out, leaving only a low flow of brackish water (Allan and Warren 1993). In Saudi Arabia, aquifers are being depleted by water used in wasteful forms of irrigation that cause salinization of the soil. Heavy applications of water bring natural salts in the soils to the surface, resulting in a surface soil covered with salt crystals that renders the soil sterile unless the crystals are removed (Allan and Warren 1993). Salinization is destroying land in many parts of the world, affecting more than 30 percent of all irrigated deserts (Allan and Warren 1993).

Grassland and dryland areas are among the most threatened of all habitats, according to an appraisal of ecosystems and centers of biodiversity that has designated 200 ecoregions in the world (Grove 1999). These include temperate grasslands and Mediterranean-type shrublands, which are also rich in diversity (Grove 1999, Mittermeier *et al*. 1999). Conservation plans for preserving many of these areas become ever more important as they disappear or are degraded.

The misuse and overuse of grasslands has already turned millions of square miles into shrub and desert. With the

rise in human populations around the world, the process is accelerating. Each year, an area the size of Texas turns to desert. The spread of deserts is threatening the livelihood of the 650 million people who live in these arid regions (Ponting 1991). The global warming climatic pattern may be accelerating this process. Studies in the early 1990s by the United Nations Environment Programme (UNEP) estimated an area equal to North and South America combined Œ about 8 billion acres of grassland and cropland Œ was in danger of desertification worldwide (Pitt 1993). Since then, the problem has worsened. An estimated 75 percent of Africa is already considered degraded (Simons 1994). Desertification has claimed 39 percent of the 76 million hectares (188 million acres) of once productive grassland in Mediterranean Europe and 82 percent of the 142 million hectares (351 million acres) of Western Asia's productive steppe land (Goriup 1988).

UNEP reported in 1986 that rangelands are turning to desert at an increasing rate: 85 percent of rangelands in North Africa, 30 percent in Mediterranean Europe and 85 percent in Western Asia (Goriup 1988). Some studies have projected that should present trends continue, within 30 to 40 years, over half of the African continent, much of Central Asia, the majority of southern and eastern South America, most of central and western North America and about 90 percent of Australia will become desert (Allan and Warren 1993).

Preserving Dryland Ecosystems

While there are treaties and international campaigns to save wetlands and forests, grassland and desert preservation has been accomplished on a national and regional basis. Some countries, including the United States, Russia, Mongolia and China, have set aside large areas of deserts, but grasslands are still considered prime grazing and farmland, an impediment to their protection. An international treaty such as the Ramsar Convention on wetlands protection (see Aquatic Ecosystems chapter) would help protect many remarkable and unique grasslands and deserts. Many have been designated as UNESCO World Heritage Sites under the World Cultural and Natural Heritage Convention for their "outstanding universal value" and/or Biosphere Reserves by the Man and Biosphere Programme**.** This has provided an incentive for protection**,** although unprotected land rarely receives such designations, which tend to be given to national parks or reserves.

The 1994 Convention on Desertification, a treaty drafted by the United Nations, attempts to slow the current trends turning grassland and shrub into desert. The treaty was negotiated at the urging of African nations attending the 1992 Earth Summit in Rio de Janeiro that requested funds for environmentally sustainable agricultural practices based on traditional methods in dryland areas (Pitt 1993). The United Nations estimates $10 billion to $22 billion will be needed annually over the next 20 years to finance the rehabilitation of land and arrest the desertification processes (Simons 1994). This treaty is one of the first to mandate cooperation with local communities and design methods incorporating input from local people. In late 1996, the Convention went into force, although the United States still had not ratified it. Estimates of the funding needed to slow the expansion of deserts rose to $43 billion by 1996.

One positive development is the designation of the Great Gobi National Park of southwestern Mongolia. The United Nations Development Programme, as part of a worldwide project financed by the Global Environment Facility organization, established a Mongolian biodiversity program with help from the Mongolian government (Possehl 1995). The United Nations agency has helped finance the park, one of the largest in the world, by funding the salaries of rangers who patrol on camels (Possehl 1995). The park is dotted with oases greened by poplar and tamarisk trees, waterholes and shrub vegetation. It has been divided into two sections that cover over 17,000 square miles. This

commitment to conservation on the part of such a poor country is extremely laudable.

The Convention on Biological Diversity, drafted at the Earth Summit in 1992, has provided funding for the purchase of drylands and grasslands through the Global Environment Facility, a financial institution created at the Summit (Mittermeier *et al*. 1999). Through this institution and other international funds, areas of biological importance have been protected, but much money has been wasted on expensive consultants and projects that did not preserve diversity (Mittermeier *et al*. 1999). The help of private organizations and more novel approaches to land preservation are needed. Conservation International**,** an organization that carries out biodiversity studies and helps protect areas rich in species, found that seven of 25 biodiversity "hotspots," covering all types of ecosystems, were mainly dryland areas; they include the Cape Floristic Province and Succulent Karoo of South Africa, Southwest Australia, California Floristic Province, the Brazilian Cerrado, Central Chile and the Mediterranean Basin (Mittermeier *et al*. 1999). They are especially rich in plants, with 61,373 native vascular species. They also harbor large numbers of endangered birds and mammals (Mittermeier *et al*. 1999).

These hotspots once covered 5,266,009 square kilometers, 30 percent of the entire land area. One region not included above, the Caucasus area between the Black and Caspian Seas of Central Asia, is part grassland and part temperate forest (Mittermeier *et al*. 1999). All of these ecosystems have been drastically reduced from their former size. The Mediterranean Basin's original dry ecosystems once covered 2,362,000 square kilometers, but they have been reduced to 110,000 square kilometers, 4.7 percent of the original area; only 1.2 percent remains of the Brazilian Cerrado (Mittermeier *et al*. 1999). None of these ecosystems is more than 27 percent of its old size. Only 154,408 square kilometers Œ 3 percent Œ of the original 5,266,009 square kilometers are protected; these areas represent 7 percent of intact portions of these ecosystems (Mittermeier *et al*. 1999).

While this seems to paint a dark picture of grassland and dryland preservation, much good is also being done. The identification and biological surveys of these areas of high diversity are major first steps. Many of these regions have been ignored both by conservationists and the nations where they are found. Once governments are informed of the biological importance and threats to these regions, many begin to set aside national parks and reserves.

The designation of reserves of temperate grassland and dryland by governments such as the United States, Canada, Argentina, Chile, Mongolia, Russia, Central Asia and China has protected portions of these ecosystems being destroyed by livestock grazing, agriculture and new human settlers. Some of the largest of these reserves have been set aside to preserve the Asian steppe. In addition to Tibet's Chang Tang Reserve, the Chinese government set aside a 6,000-square-mile area, the Taxkorgan National Reserve, an international sanctuary where Afghanistan, Pakistan, Russia and China meet (Goddard 1995).

Debt-for-nature swaps, in which a portion of a nation's debt is paid by a private conservation organization such as The Nature Conservancy, in exchange for the protection of land (generally in a national park), have been negotiated in several countries. Many of the countries harboring great biodiversity are also among the poorest, saddled with debt they are unable to pay, the result of loans made by the International Monetary Fund and the World Bank, among others, for projects such as large dams and timber extraction that often despoiled the land. A debt-for-nature swap preserved a large park in Brazil's Cerrado.

Ecosystem protection, a relatively new concept just now gaining acceptance, may become a major means of protecting the Earth's diversity. Reserves often fail to protect wide-ranging species that migrate out of them, and isolation may cause key ecological components of an ecosystem to die out, causing a biological collapse. In the United States, an organization of biologists and conservationists has urged protection of the Yellowstone Ecosystem, a mosaic of savannah, temperate forest and mountain environments surrounding Yellowstone National Park. The size of the park does not allow movements of its wildlife outside the park, such as the migrations of American bison (*Bison bison*), dispersal of grizzly bears (*Ursus arctos*) or the reintroduced gray wolf (*Canis lupus*), because cattle ranches and other private property now surround the park. Another even more ambitious proposal aims to link Yellowstone with other federal lands in the United States and Canada north to the Yukon, purchasing private lands where necessary, to create a wide corridor of undeveloped land. This would allow herd migrations and movements of carnivores to link them with other populations, while protecting the environment and species diversity. Such programs would help ensure permanent conservation of the region. A similar proposal in southern Africa would create a vast park system, stretching from southeastern South Africa north to Kenya, so that wide-ranging grazing animals and their predators could migrate freely.

The benefits to society of such preservation are significant. Ecotourism has a potential to make such projects pay for themselves. This industry is growing astronomically and yields far more income than consumptive uses of nature, such as trophy hunting, logging and mining. Likewise, use of video cameras in parks and reserves connected via satellite to the Internet for pay-per-view has emerged as a potentially enormous source of income for the funding of biological studies**,** national park expenses and land preservation.

Many organizations and scientific bodies have made great steps within the past decade to alert the public about the need to preserve these threatened grassland and dryland ecosystems. Books on the beauty and wild fauna and flora of the Serengeti, Tibet's steppe, and America's prairies, as well as films and television programs, are educating people about these beautiful areas.

Lady Bird Johnson, wife now-deceased former President Lyndon B. Johnson, initiated a program of planting wildflowers along the nation's highways. Traditionally, endless miles of clipped grass lined United States highways with cultivated flower beds in places. In much of the country this has not changed. Mrs. Johnson convinced the Department of Transportation to set aside less than 1 percent of the highway tax funds to be devoted to the planting of native wildflowers, and helped found the National Wildflower Research Center, which is dedicated to conservation and education (described in detail in *Wildflowers Across America* (Johnson and Lees 1993). The dazzling display of Texas wildflowers the Center has helped conserve draws tens of thousands of visitors from around the country. This work has directed attention to the conservation of native wildflowers, an important step to encourage protection of their ecosystems as well.

Within the past decade, the protection of remaining grassland, as well as its restoration, has taken hold in the United States, sponsored by states, private organizations and the federal government. Many student projects have involved propagation of native grassland plants for restoring these habitats. The establishment of the country's first tallgrass national park has been a recent highlight of these trends.

Worldwide, a similar effort is needed to restore these magnificent habitats. Grasslands have been "so massively transformed by the hand of man that one is hard put to find any landscapes in them that match the original," and if "ever a biome needed a champion, it is the grassland", Warwick Tarbotoni once said (*Africa--Environment & Wildlife*, November 2000). The rich variety of plants and animals native to grassland and shrubland ecosystems is being preserved in parts of the world as more people gradually see these environments not as grazing land for livestock or potential farmland, but as vital to the preservation of diversity of their region.

To preserve dryland from overgrazing by livestock, new approaches are being explored. Portions of Saudi Arabian desert have been fenced off from livestock on an experimental basis, and native plants reemerged from long dormancy, covering the sand in green. Much of this region (and the Sahara) is sandy desert; herds of camels, sheep and goats owned by nomadic people are allowed to graze year-round, eliminating the seedlings that attempt to regenerate. In an innovative approach to helping desert people survive without destroying deserts in the process, several villages in southern Africa have agreed to fence their livestock and stop gathering wood for firewood. They will use methane gas fuel generated from animal dung for their cooking and heating needs. These villages have also been supplied with electricity from solar roof panels and small wind turbines. Without furnishing a solution to the needs of desert inhabitants who depend upon their livestock, one cannot expect these people, many of whom live on the edge of poverty and hunger, to preserve desert vegetation. Solar collectors, solar-powered stoves, technology to produce methane from livestock dung and information on water conservation should be provided by international conservation organizations and governments through foreign aid.

Threatened Species

Over the millennia, vast herds of hoofed animals grazed grasslands throughout the world. In spite of their great numbers, they did not overgraze or destroy these habitats, migrating before the soils were robbed of nutrients and wild plants died out. Natural grassland can support at least 30 species of large ungulates without being damaged, but can be destroyed by a single kind of domestic livestock grazed in large numbers. Over the past few centuries, sheep, goats, cattle, yaks and other domestic livestock have greatly increased in number, either herded by nomads or grazing on private and public lands. The effects on native wildlife, especially ungulates, have been catastrophic. They have been crowded out of their habitats, and in many parts of the world, livestock has transmitted lethal diseases such as anthrax and rinderpest to wildlife, resulting in massive die-offs, endangering many species. Some African antelope and zebras, for example, have been reduced to a tiny fraction of their original populations and survive only in reserves. Even these reserves can become islands surrounded by development outside, which isolates the wildlife into zoo-like environments. Such wildlife often becomes inbred and extinction-prone.

Just how many species native to grassland and dryland habitats are threatened has not been calculated by either the 1994 or 1996 *IUCN Red List*. Only for birds have such analyses been made. BirdLife International, in *Birds to Watch 2: The World List of Threatened Birds* (Collar *et al*. 1994), concluded 6.3 percent of all threatened birds were grassland species, and a slightly larger percentage, 9.3 percent, were native to shrub and desert. Thus, 15.6 percent of the world's 1,111 threatened birds (173 species) inhabit grassland, shrub or desert (Collar *et al*. 1994). This is a significant percentage of the world's birds, and it is evidence that these regions are under great siege from a variety of factors. In the *2000 IUCN Red List* (Hilton-Taylor 2000), only forest areas had more threatened birds than shrubland

(about 22 percent) and grassland (15 percent). Likewise, for 515 threatened mammals, grassland was the second most important type of habitat after forests, with approximately 18 percent of all threatened species. Some 8 percent inhabited a shrubland (Hilton-Taylor 2000), and semi-desert and desert provided key habitats for many other mammals.

Loss of habitat is the primary threat to the species, but other causes include decreasing water tables and desertification, competition for food with livestock, and mining or other activities that completely eliminate habitats. Hunting and persecution in these open habitats is another threat to grassland and dryland species**.** Large mammals of open grasslands and deserts are highly vulnerable to hunting and persecution by nomadic herders who consider them unwelcome competitors for grassland.

The introduction of exotic plants has destroyed many bird habitats because some species are dependent on a certain type of vegetation for food or cover. Some plants have been deliberately spread, and others were nursery and garden plants that spread to the wild. Such introductions have been catastrophic in some areas, when exotic species of grasses and shrubs overtake native vegetation. The latter type rarely provides habitat or food supply for resident wildlife. In some cases, birds rely on a very specific type of habitat, such as grassland with scattered shrubs of native species. Birds and other wildlife with such specialized requirements are highly vulnerable to disappearance due to human-caused changes.

Off-road vehicles driven on fragile desert soils have destroyed habitats for a wide range of species. They cause instant mortality to tortoises, lizards and other animals, crushing them under their wheels and destroying their underground burrows. These vehicles kill slow-growing plants that are easily uprooted from the sandy soil. Dryland plants anchor the soils and provide a lifeline of shelter and food for native wildlife. Desert soils have thin layers of lichen on the surface that prevents soil particles from being blown away by the wind. Trampling by livestock and crushing by vehicular traffic destroys this fragile soil cover, promoting erosion and devegetation. In many parts of the Sahara, the Saudi Arabian Peninsula and portions of American deserts, off-road vehicles have eliminated virtually all vegetation, causing local extinctions of native wildlife.

Building fences for livestock or agriculture has also proved lethal to millions of wild ungulates, preventing their natural migrations and causing mortality when they attempted to leap over them. In Africa, Australia and North America, millions of animals have crashed into fences, subsequently dying from the collisions, starvation or dehydration as they were prevented from reaching vegetation and water. Few governments have legislation or sufficient parkland to protect wildlife threatened by the great numbers of livestock now grazing throughout the world. Grassland that once stretched from horizon to horizon has been converted to pasture and farmland in nearly every region of the world, leaving only bits and pieces of the original ecosystems. As humans migrate into the last of this wild grassland, they are obliterating native plants and animals. Should these trends continue, almost no native wildlife will remain outside national parks (Simon 1995). Much ecological damage is being done to fragile ecosystems that were never ecologically suitable areas for livestock grazing and are unable to recover from overgrazing.

Drylands of the World
EURASIA
Page 1 (Central Asia Steppe)
Page 2 (Former Soviet Union)
Page 3 (Ukrainian Steppe)
Page 4 (Himalayan Region)

NORTH AMERICA

Drylands of the World: EURASIA: Page 1

The central Asia steppe represents the largest remaining expanse of grassland in the world, but even it has been greatly reduced. A few hundred years ago, it stretched from Eastern Europe and the Black Sea east to the west side of China, a distance of 3,200 miles. The steppe is dotted with lakes, rock outcroppings and woodland copses framed by distant snow-capped mountains. Desert, dryland and grassland all occur here; some recent films and books capture the stark, haunting beauty of this region. Until the 20th century, wonderful wildlife spectacles could be seen. Great herds of saiga (*Saiga tatarica*), antelope-like ungulates, darkened the plains in the millions. Asiatic asses (*Equus hemonius* and *E. kiang*), deer, antelope and gazelles lived among the saiga on both grassland and shrub, while wild yaks (*Bos mutus*) and Bactrian camels (*Camelus bactrianus*) were confined to desert areas. Grazing animals and rodents were preyed upon by a variety of foxes, brown bears (*Ursus arctos*) and gray wolves (*Canis lupus*). Many wild cats were widespread, including the lion (*Panthera leo*) and the cheetah (*Acinonyx jubatus*), both of which have been virtually exterminated.

Drylands of the World: EURASIA

Portions of Europe were grassland until fairly recently. In the late 19th century and post-World War II period, many Western European regions that had been used for livestock came into agricultural cultivation to revive their national economy (Goriup 1988). In France, 99 percent of the dry grassland of Champagne was turned into intensive

crop-growing fields after World War II, causing many bird species to disappear. This pattern has been repeated in many parts of the world where human populations are rising.

Drylands of the World: EURASIA: Page 2

Among the most dramatic examples of agriculture on grassland and dryland are the development projects of the former Soviet Union. The western edge of the Asian steppe on the Black Sea in the Ukraine was turned to farmland during the mid-19th century. German settlers arrived, then plowed the soil for farming and introduced large numbers of livestock. Military colonies of some 60,000 men were established by the Russian government by the 1840s (Stewart 1992). By the 1860s, the once fertile soils eroded, and droughts brought famines. A series of crop failures caused the deaths of 500,000 people in 1891-92 and droughts continued during the early years of the 20th century (Stewart 1992). These grasslands had provided habitat for large numbers of Saiga and other wildlife over thousands of years.

What remained of the fertile soils became the object of the Soviet Union's settlement and cultivation program, beginning in 1929 with the announcement of a five year plan: "We must discover and conquer the country in which we live– Our steppe will truly become ours only when we come with columns of tractors and ploughs to break the thousand-year virgin soil" (Ponting 1991). When the steppe was plowed, dust storms and erosion resulted in a parallel to the Dust Bowl of the Great Plains in the United States, occurring at about the same time. Dust storms in the Ukraine blew millions of tons of top soil away, but the program continued. Collectivization of farms by Communist leaders brought even more of this rich land under the plow, and in 1954, Soviet Leader Nikita Khrushchev ordered that 90 million acres be cultivated to feed the entire Russian population (Stewart 1992). Erosion then became so severe that large areas became wasteland; in the years since 1964, portions of the steppe have been closed off to plowing, and better agricultural methods came into use (Stewart 1992).

Yet another Soviet agricultural plan destroyed an additional area of steppe. Large portions of Kazakhstan and Uzbekistan, an area of 100 million acres, were plowed between 1954 and 1960 (Ponting 1991). Land became eroded and infertile at a rate of 3.5 million acres a year prior to 1963; by 1965, more than 40 million acres, half the area, were badly damaged (Ponting 1991). More than 1 million acres of farmland were abandoned every year from the mid-1960s on in this region (Ponting 1991).

The lands south and west of the Aral Sea were another target for the Soviet agriculture programs, and the Amu Darya, Murgab and Tedjen Rivers that fed this sea were redirected south to a manmade canal leading to the Caspian Sea (Sparks 1992). These waters irrigated Uzbekistan's deserts, where monocultures of cotton were grown. The soil became topped with salt, however, as often happens when fresh water is pumped into parched land, drawing saline to the surface (Sparks 1992). The salts and agricultural chemicals polluted the soil to the point that by the late 1980s, the region represented one of the worst cases of ecological despoliation in the world (Sparks 1992).

Drylands of the World: EURASIA: Page 3

One of the last vestiges of untouched Ukrainian steppe has been preserved in a magnificent reserve, the

Askaniya-Nova, which covers 27,500 acres. In fact, it is one of the last examples of virgin steppe in the world (Durrell and Durrell 1986). Established in 1878 by Friedrich Falz-Fein, a wealthy landowner and descendant of a German settler, the land was originally used as a sheep farm. Native wildlife species were gradually introduced into the steppe, and mounted shepherds guarded them (Stewart 1992). Bobac marmots, which have become rare on the steppe, live in the reserve in colonies, and many native reptiles and amphibians survive here Œ safe from the agricultural development that surrounds them. Some 450 species of plants grow in Askaniya-Nova's grasslands, turning the land into a blaze of color in the spring with the blooms of thousands of wildflowers (Durrell and Durrell 1986). The area is reintroducing the great bustard, one of the many species of birds that almost disappeared. (*Otis tarda*).

Covering 1.6 million square miles (4.5 million square kilometers) in a belt between 200 and 600 miles wide, the steppe to the east remained lightly grazed by domestic livestock, and uncultivated until the 20th century. The native grasses of the steppe formed a tough turf, mainly of wild oat, rye grasses, sedge and fescue (Sparks 1992). These grasslands date back to the Pliocene Era, 7 to 10 million years ago. In some areas, the soil, known as *Chernozem* or black earth, is more than 3 feet deep and extraordinarily rich (Stewart 1992). In the south, graceful feather grasses (Stipa) use felt-like down to trap a layer of air to reduce water loss because of evaporation (Stewart 1992). Wild tulips, crocuses, irises and hyacinths color the steppe in spring and summer. The famed Russian author, Nicolai Gogol, described it as a "green-gold ocean splashed with millions of different colored flowers" (Stewart 1992). Diversity in the wild steppe is high; some 80 species of plants grow in a single square meter (Sparks 1992). Scorching heat up to 104 degrees F in the summer has stimulated the evolution of drought-resistant grasses.

The saiga was the dominant animal in this ecosystem, ranging in herds numbering in the tens of millions, making it the ecological equivalent of the American bison. Its distribution during the Ice Ages nearly circled the world, extending from England across Europe and throughout the entire Asian continent to western North America, which the species reached by land bridge. Saiga became extinct in North America and western Europe thousands of years ago, but until recent centuries, they ranged through most of northern Eurasia, from Poland south to Romaina and the southern Carpathian mountains and east to Mongolia and western China. This animal is a zoological curiosity, seeming to be part goat, part sheep and part antelope. Scientists were at a loss for hundreds of years to classify it. It has now been placed in the Bovidae family with wild cattle, gazelles and antelope, in its own genus and subfamily. At about 5 feet long and 31 inches tall at the shoulder, saiga males weigh up to 152 pounds and have short, spiraled horns. Females lack horns and are slightly smaller. Both have a heavy wool-like, buff-colored coat. The most extraordinary characteristic of these animals is their bulbous noses, which have greatly developed and complicated bones (Nowak 1999). The humped nose contains a sac lined by mucous membranes, an adaptation for warming and moistening inhaled air in the freezing winter weather. In warmer parts of the year, the membranes filter out the fine grit carried on the wind in clouds of dust (Sparks 1992).

The arid, open grasslands provide an ideal habitat for saiga, which can subsist on plants that are bitter and even toxic to other wildlife. They are capable of surviving the brutal, howling winds of the Central Asian winter, where temperatures reach -20 degrees F, and even begin courtship rut when snow is still on the ground in December (Sparks 1992). After mating, the herds migrate north, traveling up to 930 miles from their breeding areas in groups of 100,000 (Sparks 1992). They are able to streak across the steppe at speeds up to 50 miles per hour, covering 75 miles in a day (Nowak 1999). In May, when they have arrived at lush grassland, the calves are born. By August, they move south to wintering quarters, forming large herds again. The gray wolf and saiga have had a close ecological relationship for thousands of years as interdependent predator and prey, but today both are threatened.

Saiga were exterminated in the Crimea as early as the 13th century, but survived in the southern Ukraine until the 1700s (Nowak 1999). In the mid-19th century, a massive slaughter of saiga commenced, concurrent with that of the American bison and pronghorn in North America. They were eliminated in the entire central portion of their range from Kazakhstan to western China, thousands of miles to the east. The near-extermination of the Saiga occurred for a frivolous purpose: to obtain their horns to be ground up into powder sold as an aphrodisiac. The multitudes of saiga were reduced to less than a thousand animals by the first decade of the 20th century (Nowak 1999). Extinction

appeared a likely prospect when the Soviet government banned all saiga hunting in Russia in 1919, and four years later extended the ban to Kazakhstan (Stewart 1992).

Their numbers began to climb, but saiga encountered other difficulties that pushed many of their populations closer to extinction. The animals have been blocked by fences constructed in the 20th century in many parts of the steppe. Thousands have died after crashing into them at night at great speed. On one state farm, 300 were found dead in a single day, piled up against the fences (Stewart 1992). They have also drowned in irrigation canals, though in recent years, efforts have been made to prevent such deaths (Stewart 1992). Killing round-ups still occur, however, and by some reports, helicopters were used to herd the saiga until they collapsed in exhaustion; they were then machine-gunned (Stewart 1992). However, they recovered to more than 1 million animals by the 1970s, when another killing spree began. High prices were offered for their horns in the Asian folk medicine market, and the collapse of the Soviet Union in the early 1990s ended anti-poaching controls. Their population in Kalmykia declined from 800,000 in the 1970s to 120,000 in the 1990s (Nowak 1999).

Contamination of their steppe habitat in Uzbekistan from manufacture of chemical weapons has also killed the saiga. In 1988, thousands dropped dead on the Ustgart Plateau south of the Aral Sea when the wind unexpectedly shifted during a test at a nearby chemical weapons plant (Miller 1999). The heart of this species' population is now in the region north of the Aral and Caspian Seas in Kazakhstan, where the nominate subspecies (*Saiga tatarica tatarica*) survives. The massive killing caused their numbers to drop from 1.2 million to less than 600,000 (Chan *et al*. 1995, Nowak 1999). The price of their horns declined in the mid-1990s, perhaps as a reaction to the listing of the species on the Convention on International Trade in Endangered Species.

Only two small, highly endangered populations of their second subspecies, *Saiga tatarica mongolica*, survive far to the east in northwestern Mongolia. According to the IUCN (1994), a herd in the Shargiin Gobi that numbered 1,600 in 1989 declined to between 300 and 1,000 by 1993, while the other in Har-Us-Nuur totaled only 36 animals in 1989. Dr. Ronald Nowak, author of *Walker's Mammals of the World*, estimates their population at only about 300 (Nowak 1999). In any case, the Mongolian saiga is extremely endangered and lacks a strong conservation program to ensure its recovery. Their numbers continue to decline from poaching, severe winters and summers and genetic isolation (IUCN 1994). Although legally protected from hunting, no reserve has been set aside for them and there are no patrols to prevent poaching (IUCN 1994). They represent the last of the eastern saiga herds that inhabited the desert regions of western China and Mongolia, and they have lost 80 percent of their range. Efforts are being made by nomad herders to reintroduce the species into the Great Gobi National Park in southwestern Mongolia; young saiga calves are placed with domestic goats who foster-parent them (Schaller 1990), a potentially dangerous method if the calves imprint on the goats, possibly resulting in saiga trying to mate with goats upon reaching sexual maturity.

Few people from Western Europe or North America have seen saiga in the wild, and they are extremely rare in captivity. The late Gerald Durrell, a British zoologist and founder of Jersey Wildlife Preservation Trust, visited a Russian reserve called Kalmyk in the 1980s. He described the terrain as flat and dry, covered with golden grasses the exact color of the saiga's coat (Durrell and Durrell 1986). Lovely demoiselle cranes (*Anthropoides virgo*) fed in the grasses, and after a seven hour drive on the steppe, having passed only one village, they saw a huge herd of saiga grazing. "They were a magnificent sight as they moved slowly across the steppe with the colored sky and the sinking sun as a backdrop, the young giving strange, harsh, rattling bleats to be answered in deeper tones by their mothers" (Durrell and Durrell 1986). The next day, they found even bigger herds "until the ground seemed to be a sea of saiga." They filmed with great difficulty because the saiga were still wary and shy, but finally succeeded in driving a herd toward the camera. The film was shown on the series fiDurrells in Russiafl (see Video, Regional, Eurasia).

Another native ungulate came close to total extinction. Przewalski's horses (*Equus przewalskii*) Œ stocky and wild Š once ranged throughout the steppe. Some experts believe they evolved 150,000 to 250,000 years ago in the region, while others consider them to be a strain of the domestic horse (Nowak 1999). These sturdy, robust horses are uniformly tan with a stiff black mane, long black tail and black lower legs. For thousands of years they survived harsh climates, as long as grass and water were available. Their original range encompassed steppe from Kazakhstan, east

through Mongolia to Sinkiang, China, and possibly to southern Siberia (Nowak 1999). Soon after their discovery by Western scientists in 1879, they suffered steep declines from heavy hunting, and were crowded out of much of their habitat by growing numbers of livestock; by 1950, they had become confined to southwestern Mongolia and adjacent China (Nowak 1999). These last horses died out sometime after 1969, the year they were last seen, and subsequent searches for them proved fruitless (Nowak 1999).

Fortunately, some Przewalski's horses were taken into captivity and shipped to Europe early in the 20th century. The captive horses bred, providing animals to restock their original habitat. Many zoos now have small numbers of these horses, with a total captive population of about 1,000 (Nowak 1999). During the late 1990s, about 100 horses, now in their 13th to 15th generation in captivity, were released in the Hustain Nuruu Reserve southwest of Mongolia's capital city, Ulan Bator (Possehl 1995). They are being heavily guarded by herders, and despite some anxiety that they would not be able to adjust to living in the wild, they have shown every sign of adapting to their new environment. Stallions immediately began competing for harems of mares, and they seem to be exhibiting the natural traits of other wild horses.

Drylands of the World: EURASIA: Page 4

To the southeast, many of Pakistan's high plateaus and Himalayan foothills have become overgrazed and denuded of vegetation, leaving a desolate landscape. The Indus Plain and Karchat Hills have become a stony wasteland with stunted acacias scattered about; thin goats scour the terrain for blades of grass and people cut what few trees remain for firewood (Schaller 1980). In his book about the Himalayas, *Stones of Silence*, Dr. George Schaller (1980) imagined the land as it had once been: "Had man not misused this land for thousands of years, I would be driving through woodland, with wild asses standing in the broad-crowned shade of acacias and cheetah stalking unsuspecting Indian gazelles through swords of golden grass. Perhaps down by the river a pride of lions would be resting after the night's hunt. The forests are gone now, the rivers dry except after a downpour, and the lion, cheetah and asses are dead. Only a few gazelle remain. No wonder the land seems lonely as one drives toward the distant hills, trailing a funnel of red dust made incandescent by the sun."

Two types of wild asses are native to the steppe. Asiatic wild asses (*Equus hemionus*) once ranged from the Arabian Peninsula to Manchuria and even western India (Nowak 1999). These elegant wild equines have variable coloration, some populations with broad, dark dorsal stripes and black legs, and others uniformly tan without black markings. All have stiff black manes. They have disappeared from much of their range and are now endangered. Only a few hundred to a few thousand survive in Iran, Turkmenistan and India; in southern Mongolia and neighboring China, they are more numerous, with more than 8,000 animals (Schaller 1998). Its total population may not exceed 10,000; it is listed as endangered by the US Endangered Species Act and as vulnerable by the *2000 IUCN Red List*. The latter publication also lists six subspecies in various degrees of threat, including one, the Syrian, as extinct, with races in Iran and India as endangered (see Appendix).

The kiang (*Equus kiang*) is native to the Himalayan region, Tibet and adjacent regions of west-central China (Nowak 1999). These striking wild equines are bright russet in summer and have thick brown coats in the winter; their backs have a black dorsal stripe, and their bellies, legs, muzzle and neck are white (Nowak 1999). They prefer high elevations, up to 5,000 meters, where they forage on grasses and other vegetation. Considered abundant and secure until the mid-20th century, they began a steep decline after the Chinese occupation of Tibet in 1950. Large numbers of Chinese immigrants hunted them and displaced them with agriculture and livestock (Nowak 1999). One race native to western China and adjacent Tibet and India, E.k.polyodon, was thought extinct until a herd of 74 to 120 animals was discovered in Sikkim, China; elsewhere they remain much reduced from former numbers.

Grassland still covers much of Mongolia and Tibet, but vast numbers of domestic animals, yaks, sheep, goats and

camels graze in this fragile, arid land. Mongolia has a human population of 2.5 million, and 28 million livestock inhabit its 604,800 square miles. Livestock graze in the Gobi Desert's more verdant portions, which are a mosaic of drifting, bare sands, shrub, grassland characterized by tall tussock grass and arid mountains. Saiga once roamed here, and many extraordinary creatures cling to their existence.

Most of the world's remaining wild Bactrian camels survive in Mongolia's Great Gobi National Park. These camels differ from their domestic counterparts, which have large, misshapen humps, in being slender with trim, conical humps, sandy coats and sparse wool (Schaller 1990). Once widespread and abundant, this species is near extinction, as it is crowded out by hordes of livestock, including domestic camels, and often shot on sight by nomads and professional hunters. Their young have had low survival rates in recent years, and little is known of their reproductive biology that would explain this mortality (Schaller 1998). Herd size has also declined since the 19th century, when numbers in the dozens up to a hundred were seen. This may affect their vulnerability to predators, such as wolves. They are further threatened by interbreeding with domestic Bactrian camels; Gobi Park personnel have shot several hybrids in recent years (Schaller 1998).

Despite their large reserves, human activity is threatening the last of these superbly adapted wild camels. A 1994 film by Survival Anglia, fiMountains of the Snow Leopard,fl gauged their total population at only about 300. An aerial survey of the park in March 1997 recorded 314 camels and estimated total park population at 900 animals (Schaller 1998). In the Taklimakan Desert to the west, several other populations survive. One herd near Lop Nur, a lake dried up by irrigation diversion, had an estimated 200 animals in 1985, but they declined to only 80 to 100 in 1995 after a period of heavy hunting (Schaller 1998). Further west, a road built through their habitat near the Tarim River, combined with oil development, reduced the wild camels to only 50 to 80 animals (Schaller 1998). The total world population of these progenitors of domestic Bactrian camels is only about 1,500, while at least 2.5 million domestic camels inhabit central Asia (Schaller 1998).

An extremely rare predator, the Gobi bear (*Ursus (arctos) gobiensis*), is also resident in the Great Gobi National Park. Schaller (1998) and others consider it to be so distinct that it is a separate species from the brown bear (*Ursus arctos*). If recognized as so, it would be the rarest carnivore in the world, numbering only about 30 animals in a population isolated from other brown bears by hundreds of miles. They have apparently been separated for a very long time. Its closest relative, the endangered Himalayan brown or red bear (*Ursus arctos isabellinus*), occurs to the west of the Gobi with a range that extends to Nepal. Populations in Mongolia are listed on Appendix I of CITES, but Gobi bears have yet to be recognized by CITES, the *IUCN Red List* or the US Endangered Species Act. Fortunately, they receive protection in their sole remaining range within this park. They are the world's only true desert bears, and they subsist in extremely arid conditions, feeding on scarce tubers and wild plants. Yellowish-brown or reddish with dark legs, Gobi Bears are relatively small and lanky, weighing less than 200 pounds, about one-tenth the weight of their cousins in Alaska and Russia's Kamchatka Peninsula. fiMountains of the Snow Leopardfl (see above and in Video Section) is the first film record of Gobi Bears ever made. A female was filmed with her half-grown cub, scratching in the sand for wild rhubarb.

The bears to the west on the Tibetan Plateau are quite different in their appearance. Shaggy rather than thin-coated, they often have a conspicuous white collar, dark brown to black coats and rusty faces. Their black ears appear to be adorned with tassels (Schaller 1998). They are known as Tibetan bears (*Ursus arctos pruinosus*), listed as endangered by the US Endangered Species Act. Extremely rare on the steppe, they survive only in mountainous terrain, and have disappeared from the alpine meadows near the Yellow River where they were once common (Schaller 1998). They are severely persecuted by Tibetans, who usually kill them on sight (Schaller 1998).

A rare and dazzling resident of the Great Gobi National Park is the Houbara bustard (*Chlamydotis undulata*), a threatened relative of the great bustard. The bustard family, Otididae, with 25 species, occurs in Africa and Eurasia. These stocky, long-legged birds are distant relatives of cranes and are declining from loss of their grassland habitats and hunting. In the dryer steppe, where vegetation is brown and shrubby, the male Houbara bustard stands out dramatically, dashing about and displaying a long chest ruff of white Ostrich-like feathers surrounded by jet black

quills that he jerks as he dances a high-stepping strut. His erected white head feathers resemble a puffy hat.

To the southeast, the graceful Tibetan gazelle (*Procapra picticauda*) is endemic to the Tibetan Plateau, which abuts southern Siberia and western China. Early in the century, the grasslands at the headwaters of the Yellow River in eastern Qinghai, China, presented a great spectacle with enormous herds of these gazelles and other ungulates. The area is dotted with lakes and was home to wild yaks, kiangs and other wildlife (Schaller 1998). In the 1950s, roads were built, and livestock now grazes at densities of 40 head per square kilometer, displacing wildlife (Schaller 1998). Wild yaks disappeared, and kiangs and Tibetan gazelles have become rare and sparsely distributed in the region. As Schaller (1998) remarked, "One can traverse these grasslands for hours and seldom glimpse a gazelle." These gazelles and other ungulates are avidly hunted. Despite their extraordinary swiftness and great leaping ability, they cannot escape gunfire in this open habitat. Tibetan gazelles number 100,000 at most throughout their enormous range (Schaller 1998).

The influx of herders and farmers into these grasslands has been a result of an official Chinese government program which encouraged people from crowded urban areas to enter frontier regions of the west to settle. These new residents converted the steppe into farms and grazing land (Hsu 1988). Three-quarters of these steppe, 266 million hectares (657 million acres) of a total 358 million hectares (885 million acres), had become grazing or farmland by 1988 (Hsu 1988). Since then, this trend has accelerated. These wilderness areas are officially classified by the Chinese government as "wastelands" (Hsu 1988). Other types of wildlife are being eliminated, as well as hoofed animals. Rodent control programs poison pikas and ground squirrels. Some reserves have been set aside which protect at least a portion of the Chinese steppe. The Xianghai Nature Reserve, for example, covers 100,000 hectares (247,000 acres), but livestock and hunting are allowed in these reserves.

In 1993, the Chinese government established the Chang Tang Nature Reserve, an area of Tibetan steppe with breathtaking scenery of distant mountains and steppe dotted with icy lakes, larger than the state of New Mexico. Dr. George Schaller and his organization, the Wildlife Conservation Society, played an important role in the establishment of this reserve, which provides habitat for some of the steppe's most endangered species. His 1997 book, *Tibet's Hidden Wilderness: Wildlife and Nomads of the Chang Tang Reserve*, is illustrated with photographs of this magnificent region and its wildlife. Stunning mountains covered in snow, grassland oases and beautiful gazelles and antelope distinguish this wilderness. A companion book by Schaller, *Wildlife of the Tibetan Steppe*, provides more scientific detail on the biology, ecology and status of the wildlife of the entire region (Schaller 1998).

Chang Tang Reserve allows large numbers of pastoral people to graze their livestock, and approximately 22,000 people live in the reserve, with 1.4 million livestock Œ most of which are sheep (Schaller 1997). The livestock have displaced many wild herds, which now number only about 103,000 animals, 10 percent as numerous as the domestic animals. The huge numbers of livestock give an indication of the vast numbers of wildlife that once occurred on the steppe (Schaller 1997). Although quotas have been established, with maximum numbers of livestock per family at 486 animals per household in one part of the reserve, they are so generous that they leave little habitat for native wild sheep, gazelles, antelope and other wild ungulates, which are in steep decline (Schaller 1997).

A few wild yak (*Bos grunniens mutus*) herds inhabit Chang Tang. These extremely imposing animals are far larger and more massive than their domestic counterparts, with humps on their shoulders and shaggy black coats that nearly reach the ground. They survive in a few scattered herds, a result of heavy hunting. In the Aru Basin in the reserve, where a Pleistocene-like panorama of wild herds of many species existed as recently as 1990, yak numbers have been halved by hunting and the introduction of livestock and permanent settlements (Schaller 1997). Only about 15,000 of these magnificent animals remain, the majority surviving in three reserves on the Tibetan Plateau (Schaller 1998).

Tibetan antelope (*Panthops hodgsoni*) are native to this extremely harsh Tibetan steppe, which is swept by howling winds throughout the long winters. The male has long, straight horns that rise almost vertically from its head and bend forward at the tip. Their faces and front legs are black. Males weigh only about 100 pounds. Females are smaller and lack the male's horns. Both have buff coloration that blends into the pale tans of the steppe. Although

considered antelope, recent DNA studies have determined they are more closely related to goats; they retain some ancestral characteristics of both antelope and gazelles (Schaller 1997). Chiru have unusual physical adaptations to cope with the high-altitude environment Œ such as an extremely fine fur Œ which has made them the target of hunters, an enlarged nasal cavity to draw in the thin air on their long migrations, and high-crowned teeth to grind the tough vegetation.

Chiru were abundant until the 20th century. In 1897, a British military officer came upon enormous herds: "As far as the eye could reach, were thousands upon thousands of doe antelope and their young...there could not have been less than 15,000 or 20,000 visible at one time" (Schaller 1996). Heavy hunting for its fine wool, Shahtoosh, has been a major cause of its decline throughout this century. This wool is extremely valuable, and has reached luxury markets in western countries in recent decades (see Trade Chapter). At present, chiru still migrate in long lines for great distances over the windswept steppe, but their total population is estimated at less than 75,000. Although it is officially protected, illegal hunting continues, even by Tibetan government officials.

The native deer of the steppe occupy various habitats, from scattered woodlands to open grasslands. The largest species, the red deer (*Cervus elaphus*), known as elk in North America, has been severely overhunted and crowded out of its habitat. A race from Tibet known as the shou, *Cervus elaphus wallichi*, was thought extinct until a small population of 200 was discovered recently in an area east of Lhasa (Nowak 1999). Another subspecies from the steppe of western China, the Yarkand deer (*Cervus elaphus yarkandenis*), once thought extinct, numbers about 5,000 in central Sinkiang, China, with another 6,000 farmed animals (Nowak 1999). The Bactrian deer (*Cervus elaphus bactrianus*) of Central Asia nearly became extinct, reduced to only 300 to 400 animals in the 1960s from overhunting and loss of habitat to agriculture and livestock; it now numbers 900 (Nowak 1999). All three are listed as endangered on the US Endangered Species Act.

White-lipped deer (*Cervus albirostris*), found only on the Tibetan Plateau, prefer far more open habitat than most deer, especially alpine meadows; stags can weigh up to 230 kilograms and stand up to 140 centimeters at the shoulder, with large, white antlers (Schaller 1998). Heavy hunting and competition for forage with livestock have made them rare in most parts of their range, with scattered, discontinuous populations; they are common only where protected, such as in the vicinity of monasteries (Schaller 1998). Total numbers of this deer, which was once far more abundant, are estimated at approximately 50,000 to 100,000 (Schaller 1998).

A high diversity of small wild cats inhabits the steppe and deserts of Asia. Some are tiny, the size of a small house cat, and others range up to 3 feet in body length. Many have become endangered after their steppe habitat and natural prey were displaced by agriculture or livestock. Some are killed for their fur. The Turkmenian caracal (*Caracal caracal michaelis*), a sandy brown cat with long tufts on its ears, has disappeared from most of its habitat in the western steppe. Another shy and rare feline, Pallas' cat (*Otocolobus manul*), ranges from Iran to Siberia and China on rocky steppe and desert up to 4,000 meters in elevation (Nowak 1999). Having the longest, densest fur of any wild cat, this species inhabits the high-altitude rocky mountainsides and cold deserts of central Asia (Sleeper 1995). It has become very rare throughout its distribution from hunting for the fur trade and persecution by livestock owners. Weighing only 5 to 8 pounds, Pallas' cats have a thick muff-like tail they wrap around their feet for insulation in the snow (Sleeper 1995).

The magnificent Snow Leopard (*Uncia uncia*) is the largest and most endangered wild cat of this rugged region. Pursued by hunters throughout its range, which encompasses more than 2 million square kilometers of mountain ranges that extend over 12 countries, it has disappeared from the majority of its original distribution. The natural prey of these cats, wild goats and sheep, have been overhunted and crowded out of their natural habitats by livestock, forcing Snow Leopards to take livestock in some areas. The combined effects of fur hunting, persecution and loss of their natural prey are pushing the species close to extinction. Only in the past few decades have conservation programs begun to turn this downward trend around. One biologist, J. Fox, estimated total populations for the species at between 4,500 and 7,350 in 1994; in western China, they may number about 2,000, while in Kyrgystan, there may be 1,000 to 2,000; in Mongolia, approximately 1,000; India about 500; with scattered numbers in the Himalayan

countries of Nepal, Pakistan and Afghanistan (Fox 1994, Schaller 1998). For a growing number of countries, these beautiful wild cats have become a valuable asset to attract tourists and an important part of their natural heritage. Work by outside biologists and conservation organizations to persuade herdsmen not to kill them, but rather to protect their herds properly instead, is beginning to take hold in Pakistan and other parts of the Himalayas.

Drylands of the World: NORTH AMERICA

Just 200 years ago, North America's magnificent grasslands preserved the largest population of hoofed mammals in the world. Herds of American Bison totaled an estimated 60 million animals, almost 60 times the number of wildebeests that now inhabit East Africa. A mosaic of grasslands of various types stretched from the Midwest to the Pacific Ocean, merging into deserts in the Southwest. Some grassland habitats also existed in the Northeastern United States, a mixture of grassland and heath, either of natural origin or maintained by annual burns set by Native Americans. Grasslands, shrub and desert covered about one-third of the United States prior to settlement (Petty 1973). Grassland occupied approximately 17 percent; shrublands and deserts 8 percent each. Many parts of the latter areas are mixed habitats with grassland-shrub and shrub-desert communities. Grasslands once covered far more area in the Southwest prior to settlement, but today many of these have turned to desert after centuries of cattle grazing.

Drylands of the World: NORTH AMERICA: Page 1

In the early 1800s when Lewis and Clark explored the West for President Thomas Jefferson, short and tallgrass prairies occurred in a wide north-south expanse from southern Canada to the Gulf of Mexico, covering at least 1.5 million square kilometers (945,000 square miles) (Knopf 1988). Tallgrass prairie, requiring a moist environment, with 50 to 100 centimeters of rain per year, grew in the eastern section, extending in a wide north-south band from southern Canada to southeast Texas and southwestern Louisiana, and from Illinois in the east to eastern Oklahoma and North Dakota in the west. Tallgrass prairie once covered 577,500 square kilometers (365,825 square miles) (Knopf 1988). Named for the grass species within this ecosystem that reach up to 12 feet in height, it grows in thick, luxuriant stands (Brown 1985). Early settlers considered this habitat to be an impediment to farming and plowed millions of acres. Soon after European colonization, the eastern grasslands were plowed into prime farmland. Today, tallgrass prairie is reduced to less than 1 percent of its original expanses.

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The tough, compacted shortgrass of the Great Plains further west required a heavy steel plow to break it apart, which was invented late in the 19th century, opening up additional millions of acres to cultivation (Ponting 1991). The United States government encouraged settlement by giving away plots of 160 acres of land to anyone who laid claim. Settlers and professional hunters killed off the vast herds of American Bison, Black-tailed and White-tailed Deer, Elk,

and Pronghorn Antelope, as described in Chapter One. Much of what shortgrass prairie remains is federally owned.

Settlers who plowed native grasslands did not appreciate the fragility of this environment, with its low rainfall and soil anchored by grasses. The topsoil was extremely deep, 5 inches or more, perhaps the world's richest soil. It had built up over hundreds of thousands of years from grassland vegetation dying and enriching the soil, along with dung from untold numbers of bison and other ungulates. Settlers deep-plowed this virgin prairie, reaping bumper crops for a few years. They enlarged their farm acreage by removing windbreak strips of vegetation and cutting tree groves. The eradication of natural vegetation, especially trees, lowered the ambient humidity because of the massive amounts of water vapor they had emitted, reducing rainfall. The lack of contour plowing encouraged erosion, as did the removal of the vegetation that held the soil in place.

This set the stage for major droughts which began in the early 1930s, and windstorms blew millions of tons of precious topsoil off the land. The plains of Oklahoma were the first to experience massive dust storms, forcing thousands of farmers to abandon the region. The phenomenon came to be known as the Dust Bowl. Topsoil disappeared from plowed fields in Kansas, Colorado, western Texas, New Mexico, Nebraska and the Dakotas (Ponting 1991). Winds swept away an estimated 350 million tons of topsoil in a single storm in May 1934, and blinding dust storms continued throughout the 1930s, darkening skies hundreds of miles away, as far east as New York City (Peck 1990). By 1938, 10 million acres had lost 5 inches of topsoil, and another 13.5 million acres lost the top 2.5 inches (Ponting 1991). An estimated 850 million tons of soil were being lost a year by the end of the 1930s, and the United States government began a program to restore the soil (Ponting 1991). Throughout the prairies, approximately 18 million acres turned into shrub desert during the decade of the 1930s (Peck 1990).

Drylands of the World: NORTH AMERICA: Page 2

Conservation practices improved after government programs were launched to control erosion, and agricultural subsidies have been paid to farmers ever since. Unfortunately, the ecological effects of these subsidies have been extremely destructive to topsoil and wildlife conservation on the 294 million acres farmed in the country. After extensive debate in Congress, a 1996 law, the Freedom to Farm Act, authorized the phasing out of subsidies, with the eventual goal of ending them altogether.

Erosion damage is even visible from space through satellite photography (Manning 1995). Statistics in 1997 showed that conservation tillage is being practiced on 37 percent of America's farmland, while conventional deep plowing is still carried out on 107 million acres, and reduced- or no-till farming was employed on 77 million acres (AP 1998). Erosion of topsoil continues at a rate estimated to be 17 times faster than new soil is formed (TPP 2000). Farming tends to eliminate wildlife, which can be mitigated by the planting of hedgerows, woodland and other natural habitat areas.

Water supplies for prairie farmers have also been overtaxed. Many natural waterways have been diverted for irrigation, drying up wetlands. Beneath the Great Plains lie underground aquifers, fed for thousands of years by water seepage. In the 20th century, farmers and ranchers in the dryer parts of the prairie region have been over-drawing water from the Ogallala Aquifer, a subterranean lake which is due to run dry in 60 years (Stolzenburg 1996).

Of the original grasslands, more than 90 percent of prairies are now gone, plowed into agricultural fields or mowed for cattle pasture. Nearly all the free-flowing rivers and streams that water prairies and drylands have been altered forever. Government programs have straightened and drained countless natural streams and wetlands through channelization, which removes streamside vegetation, straightens the bends in these waterways and excavates straight

ditches in their place. Hundreds of miles of western rivers have been covered in stones to prevent flooding of homes on the river, but these stones destroyriparian and river ecosystems.

Drylands of the World: NORTH AMERICA: Page 3

Ecological studies of the remnants of tallgrass prairie reveal them to be extremely rich in plant diversity, with up to 500 different species (Madson 1993). Of these, at least 150 species are grasses, with about 10 dominant kinds (Madson 1993). In the eastern portions, savannah with islands of forest, or grassland surrounded by forest, dominated (Brown 1985). Further west, isolated trees or groves, primarily oaks and hickories, replaced forest islands.

In Illinois, at the eastern edge of the original tallgrass prairie, only seven hundredths of one percent remains (.07 percent); this pitiful remnant makes a mockery of the state's nickname, "The Prairie State" (Stevens 1995). The original 21 million acres of Illinois tallgrass disappeared rapidly under the plow, leaving about 2,500 acres (Line 1997), of which only 11.2 acres of untouched prairie savannah exists (Stevens 1995). Even these remnants are so fragmented and poor in species that scientists can only guess at the original components of this ecosystem.

One of the rarest tallgrass birds is Henslow's Sparrow (*Ammodramus henslowii*), a small brown-and-black striped songbird, which breeds from the Northeast west to South Dakota and Kansas and south to North Carolina. This bird prefers fairly tall native grass species with scattered shrubs and woody growth, and requires a range of at least 500 acres (Line 1997). It was first listed on the National Audubon Society's annual Blue List of declining species in 1974, and by 1986, it was reported very rare or absent in many parts of the Northeast, Appalachia and the Great Lakes region (Ehrlich *et al*. 1992). The disappearance of tallgrass prairie is directly responsible for the decline of this sparrow, and it cannot survive in the tiny fragments that persist. Henslow's Sparrow may soon qualify for listing on the Endangered Species Act. The Fish and Wildlife Service (FWS) appraised its rate of decline at 93 percent since 1966, one of the most drastic for any North American breeding bird (Line 1997). FWS considers it a Migratory Nongame Bird of Management Concern; although a 1996 status survey found the species to be greatly reduced, the Service has not designated it an endangered species (Line 1997).

Historical records indicate that Henslow's Sparrows were abundant in the Midwest, from Wisconsin through Illinois, during the 19th century. Today, these birds are so rare that birdwatchers travel for hundreds of miles to see one. Their song is very unsparrow-like, a short staccato "se-LICK" which can be mistaken for an insect's call. Only four areas in the country still contain colonies of Henslow's Sparrows with populations of 400 or more nesting pairs: Missouri; The Nature Conservancy's Tallgrass Prairie Preserve in Oklahoma; Fort Riley, an army base in Kansas; and Jefferson Proving Ground in southern Indiana (Line 1997). Fort Riley is home to other rare grassland birds such as the Grasshopper Sparrow (*Ammodramus savannarum*), which has declined 66 percent overall, and has suffered a 96 percent decline in New York State since 1966 (Line 1997). Grasshopper Sparrows prefer shortgrass and open habitats devoid of brush and weeds and prosper when grasslands are mowed annually rather than burned, leaving seeds and insects (Swengel and Swengel 1997). The Sedge Wren (*Cistothorus platensis*), a state-listed species also resides on Jefferson Proving Ground (Pruitt 1997). Almost half the base, including all the grasslands, is off-limits to human access because of an estimated 1.5 million rounds of unexploded ordnance (Pruitt 1997), a fact which may work to the benefit of these rare species since large numbers of people can disturb these birds, causing them to desert ideal habitat. The future of these birds depends on the success of various efforts to protect and restore tallgrass prairie east of the Mississippi River.

The colorful Bobolink (*Dolichonyx oryzivorus*), a member of the blackbird family, Icteridae, nested in large numbers in overgrown fields and native grassfields until the last few decades. These birds migrate in immense flocks, wintering in South America. In recent years, however, they have become rare in many areas, as more and more hay fields are mowed during their nesting periods, or plowed for agriculture. They have also lost wintering habitat to

agriculture. Bobolinks have incurred an average of 90 percent decline in the Midwest, according to results from bird censuses conducted in the early 1990s, as analyzed by the Biological Resource Division of the U.S. Geological Survey. In one New York study, hay mowing caused the loss of 94 percent of Bobolink nests, while in undisturbed fields, 80 percent of the chicks survived (Line 1997). Conservationists and ornithologists have launched education programs to convince farmers to delay mowing their fields until late summer when these birds have finished nesting.

The largest remaining area of untilled tallgrass prairie, totaling about 60,000 acres, is found in the Flint Hills of Kansas and in the Osage Hills of Oklahoma; these grasslands were not plowed because both lie atop rugged limestone rock formations and have a comparatively thin topsoil. A national tallgrass prairie park was first proposed decades ago. Private owners of the land in the Flint Hills opposed federal legislation first introduced in 1962 to create such a park and, for more than 30 years, refused to sell or donate virgin prairie that stretches for about 100 miles (Madson 1993). Finally in 1996, after decades of lobbying by conservationists, the United States Congress authorized a national tallgrass prairie park and President Bill Clinton signed the bill into law, the first federal protection for this extraordinary habitat. The new Tallgrass Prairie National Preserve in the Flint Hills of east-central Kansas covers 10,894 acres. Disputes continue with neighboring cattle ranchers opposing the preserve and recommending that the land continue as a cattle ranch, legally possible under the Preserve designation, a less stringent category than National Park. Ecologists, however, have proposed restoring the original plant life, which has become less diverse after generations of cattle grazing. The preservation of this land is a great victory for environmentalists who have long worked toward this goal. Only with time will the enmities and differences be settled, hopefully on the side of the natural environment.

In Iowa and Minnesota, the Fish and Wildlife Service is planning to establish the Northern Tallgrass Prairie Habitat Preservation Area. Through purchases of land and easements, the area will cover come 70,000 acres (Line 1997). In Wisconsin, the International Crane Foundation has reestablished prairie on its land. An innovative program in the state allows dairy farmers to set aside one third of their pasture for grassland birds, mowing or grazing it after the nesting season (Line 1997).

A substantial unplowed section of tallgrass prairie was acquired by a private conservation organization. The Nature Conservancy obtained 30,000 acres in Oklahoma's Osage Hills, a former cattle ranch, in the early 1990s. It plans to restore the original plant life, and 300 bison have already been released in the prairie (Madson 1993). This sanctuary is sizeable enough to harbor a natural tallgrass ecosystem, which ecologists have calculated should encompass at least 16,500 acres, have a population of 500 bison, and a complete watershed (Madson 1993). The new preserve is being biologically inventoried prior to reintroduction of native species.

Drylands of the World: NORTH AMERICA: Page 4

Pronghorn Antelope, once numbering in the millions in grasslands from southern Canada to northern Mexico, have disappeared from much of their former range. They have rebounded from near extinction in the Great Plains, but are rare or endangered in the desert grasslands of the Southwest and northwestern Mexico. Two subspecies are listed as endangered by the U.S. Endangered Species Act: the Peninsular Pronghorn (*Antilocapra antilocapra peninsularis*) of Baja California, Mexico, and the Sonoran Pronghorn (*Antilocapra antilocapra sonoriensis*) of the Sonoran Desert of southern Arizona, southeastern California and adjoining Mexico. These two races have become endangered by a loss of grassland to overgrazing and agriculture and by overhunting. Sonoran Pronghorn number only between 125 and 250 animals in Arizona, and an equal number are estimated to survive in neighboring Mexico (Turbak 1995). Remnant populations of this subspecies reside in the Cabeza Prieta National Wildlife Refuge, the Organ Pipe National Monument, and on an Air Force gunnery range. Smaller than the prairie races of Pronghorn, they can survive in extreme conditions of heat, aridity and sparse vegetation. It is thought that they are able to live without ever drinking water, according to *Pronghorn: Portrait of the American Antelope* (Turbak 1995). Their habitat has been severely

damaged, and most of the original grassland range of the Pronghorn in the Southwest has been lost to agriculture or has become totally barren after centuries of heavy livestock grazing.

Sonoran Pronghorn inhabiting the Luke Air Force Base in Arizona number only about 100 animals, and some have been killed by low-level flight training, air-to-ground live fire and other military activities (Stauble 1997). Since the Endangered Species Act prohibits federal agencies from harming listed animals, these activities were illegal. Defenders of Wildlife sued the Fish and Wildlife Service for allowing these lethal activities, and new monitoring procedures resulted in the cancellation of three scheduled bombings in 1997 because Pronghorn were in the vicinity (Stauble 1997).

The Peninsular Pronghorn is even more endangered, numbering only about 100 to 250 animals in the Vizcaino Desert of the central Baja California peninsula of Mexico (Turbak 1995). At one time, they were far more numerous and common in this arid region of northwestern Mexico, but they have been crowded out by development and livestock and decimated by overhunting.

The Mexican or Chihuahuan Pronghorn (*Antilocapra americana mexicana*) was once native to southeast Arizona, Mexico, and portions of Texas and New Mexico. In Texas a small population remains near the town of Marathon in Brewster County, but the Arizona Pronghorn disappeared altogether by about 1920 as a result of uncontrolled hunting, agricultural development and livestock grazing (Turbak 1995). In the 1980s, 400 Chihuahuan Pronghorn were moved from Texas to five sites in Arizona, mainly in the center of the state, and these animals are doing well, having increased to 500 (Turbak 1995). Their long-term future is not rosy, however, because of the rampant urban and suburban growth taking place in central Arizona (Turbak 1995). These skittish and extremely high strung animals do not do well in captivity, and no captive herds of either subspecies are being bred in zoos.

Three of the five native prairie dog species are imperiled. The Utah Prairie Dog (*Cynomys parvidens*) has been driven to near extinction by rodent control programs and the loss of habitat to livestock and agriculture. Listed on the U.S. Endangered Species Act, this species has a restricted range in southwest Utah. A population estimated at 95,000 animals in 1920 fell to only 3,300 in 1972 (Nowak 1991). Through protection accorded by the Endangered Species Act, Utah Prairie Dogs began to rebound, and by 1984, the species was downgraded from endangered to threatened on the Endangered Species Act. Counts of Utah Prairie Dogs in the early 1990s ranged from 6,400 in the fall to 24,000 after they had pups in the spring (Nowak 1991). The Fish and Wildlife Service began transplanting prairie dogs from private to public lands (Turbak 1993). Initially, many of the released prairie dogs failed to survive, and not until they began releasing males in the spring, who industriously spent the summer excavating burrows to accommodate other prairie dogs released in the fall, did transplants succeed (Turbak 1993).

In southern Coahuila and northern San Luis Potos, Mexico, the Mexican Prairie Dog (*Cynomys mexicanus*) has become endangered from poisoning and shooting campaigns by ranchers and farmers (Nowak 1991). They have lost a great deal of their habitat to agriculture and huge cattle ranches. The species is listed as Endangered by the U.S. Endangered Species Act as well as by the *1996 IUCN Red List Animals*.

The Black-tailed Prairie Dog (*Cynomys ludovicianus*) numbered in the billions at the time of Lewis and Clark in the early 19th century. Its range covered the millions of acres of shortgrass prairie. This species has been decimated by conversion of the land to agriculture and poison campaigns, causing declines of 98 to 99 percent (Wuerthner 1996). The Biodiversity Legal Foundation in Colorado filed a petition in October 1994 to list this species as a Category 2 species under the Endangered Species Act, a category just below threatened. Although the Fish and Wildlife Service's own biologists supported this listing, the petition was denied after political pressure from ranchers and South Dakota's Senator Thomas Daschle (Wuerthner 1996).

Conservation biologists have expressed concern that the remaining prairie dog towns are so small and fragmented that this may cause the prairie town social system to slowly disintegrate (Stevens 1995b). For a healthy prairie dog ecosystem, reserves of at least several million acres are needed for these animals to recover their natural role in the

prairies (Wuerthner 1996). Some biologists who have studied this situation think that such reserves might be established by purchasing privately owned inholdings in public lands and consolidating portions of BLM land and national grasslands.

The image of the prairie dog as a pest to be exterminated is still dominant in the American West among ranchers, and through their influence, almost all public land except National Parks and some National Wildlife Refuges is managed for livestock, with control programs to eliminate prairie dogs. Poisoning even takes place in a few National Parks that border ranches (Wuerthner 1996). The fragmentation of their populations may be encouraging outbreaks of disease in the prairie dog colonies. Sylvatic plague, a disease that was introduced to North America from Asia in the early 1900s, has swept through many prairie dog towns, wiping out entire colonies in a matter of days (Matchett 1997). The disease is carried by fleas, and prairie dogs have no immunity to the disease (Wuerthner 1996).

As prairie dog towns disappeared, so, too, did a species that is entirely dependent on them. The Black-footed Ferret (*Mustela nigripes*) exists in no other habitat. With such a complete dependence on these rodents and their burrows, the species was extremely vulnerable to declines. Even prior to the poison campaigns, these black-masked members of the weasel family, Mustelidae, had been considered rare, and it is amazing that they survive at all. Ferrets resemble their close relatives, the weasels, in being long-bodied and slim with short legs, well designed to slip into prairie dog burrows. Rodent control campaigns killed ferrets directly when they fed on the bodies of poisoned prairie dogs (see Persecution and Hunting chapter).

A population of Black-footed Ferrets discovered in a South Dakota Indian Reservation in the 1960s died out after poison control programs were implemented. Thought extinct, none was seen until 1979, when two skulls that appeared to be from recently killed ferrets were found in Wyoming. No living animals were found, however. Then in 1981, a rancher found a dead Black-footed Ferret killed by his dog, and gave it to a Wyoming taxidermist to stuff and mount. Although the rancher did not recognize the species, the taxidermist realized that the animal was an endangered Black-footed Ferret. Fish and Wildlife Service biologists came to the property, located more Black-footed Ferrets and began field research. A young male Black-footed Ferret was live-trapped and fitted with a tiny radio transmitter so that researchers could track his movements. After that, more ferrets were seen in the same part of Wyoming. Dr. Tim Clark and his associates counted 58 animals, of which 36 were born in 1982 in this population.

This newly discovered population almost died out as well, however, when canine distemper, apparently spread by a pet dog in 1985, killed the majority of the 127 Black-footed Ferrets known to exist (Godbey and Biggins 1994). Only 19 animals survived of this population, and they were taken into captivity. In 1992, sylvatic plague struck the White-tailed Prairie Dog town inhabited by the ferrets, killing most of the town.

Prior to these events, an extraordinary film, fiThe Mysterious Black-footed Ferret,fl was made by the National Audubon Society in the Wyoming prairie dog town, revealing an enchanting creature (see Video Section, Mammals). They were filmed darting rapidly about in the early morning and at night, often engaging in high-speed chases of one another, zooming in and out of prairie dog burrows and leaping in graceful figure eights. Arching their bodies in an "S" shape, they danced in circles around one another. They often seemed to be playing tag. When an unfamiliar sound that might be a hawk or owl was heard, their black-masked faces appeared suddenly at burrow entrances, and they emitted excited yipping sounds of warning. They were able to back into burrows at high speed, shuffling backwards so quickly that they were gone in the blink of an eye.

Fortunately for the species, the captive-breeding program succeeded. Breeding cages were built in Wyoming, and the project was supervised by the Fish and Wildlife Service. Most of the captive Black-footed Ferrets are housed in units with a den on a lower level connected by plastic pipe to an upper level. They apparently find the pipes satisfactory substitutes for burrows, zipping rapidly between levels, with several ferrets to each unit. Gradually, other captive-breeding centers were established, with many zoos taking ferrets. The captive population rose to 118 animals by September 1989 (DeBlieu 1993) and to 250 breeding adults by 1994 (Godbey and Biggins 1994). Between 1995 and 1997, 400 kits were produced (Line 1997b). Genetically, however, the population is in danger of being inbred,

because the entire population is descended from only 19 animals.

No further signs of Black-footed Ferrets have been found in other parts of the West, and had other populations existed, they would probably by now have been poisoned by the prairie dog campaigns that continue. The Animal Damage Control division (part of the U.S. Department of Agriculture) uses federal funds to poison prairie dogs on millions of acres of federal lands. After the species was listed by the U.S. Endangered Species Act of 1973, federal employees were required to look for signs of the ferrets, such as tracks in the dirt, prior to poisoning prairie dog towns. These signs are not always present, however, and it is very likely that many ferrets have been killed by the United States government even after their supposed protection on the Act.

The present goal of the Endangered Species recovery program for Black-footed Ferrets is to establish new populations in various parts of the West by reintroducing captive-bred ferrets into existing prairie dog colonies. This goal has been difficult to attain, however, because the majority of prairie dog towns remaining in the West, most of which are on federal land, are still being poisoned. Tim Clark commented on this situation: "Prairie dogs figure prominently in the ecology of this continent. Does it make sense to try to eliminate prairie dogs and then turn around and declare ferrets endangered and spend of a lot of money attempting to restore them? We'd never think of burning a museum, yet when it comes to our biological heritage, we don't hesitate to bulldoze it, burn it, or plow it under...To avoid that, we should be protecting prairie dog habitat" (Long 1998).

Black-footed Ferrets require a large territory and, therefore, a sizeable prairie dog town. In 1991, after much searching, a release site was found north of Laramie, Wyoming, and 49 ferrets were set free; by the following spring, two of the females had produced litters (DeBlieu 1993). High mortality marked the first releases because these animals had not been conditioned to cope with natural predators. In 1992, another 90 animals were released, after a period of training in which they were kept in an outdoor pen with prairie dogs; this greatly improved the survival of released animals. Experiments in which ferrets are born and raised in dirt-filled pens with prairie dog burrows and live prairie dogs have produced the most successful adaptations to the wild of all (Matchett 1997). Disease still presents a danger: Of 228 ferrets released in Wyoming's Shirley Basin, only about six animals survived after plague broke out (Line 1997b).

The recovery programs have been conducted with the cooperation of state, federal, local and private concerns, and include education campaigns. Prior to the release of ferrets, local ranchers and others were consulted, and fears that prohibitions of the Endangered Species Act might cause problems if any ferrets were accidentally killed were allayed by the ferrets' designation as "nonessential experimental populations," which allows accidental killing without penalties.

In 1993 and 1994, more Black-footed Ferrets were released in the 1.1 million-acre Charles M. Russell National Wildlife Refuge in Montana in Black-tailed Prairie Dog towns; six of the 12 ferrets were killed by predators, but five of the 1994 releases survived, according to the Fish and Wildlife Service. Additional releases in 1995 and 1996 totaled 119 ferrets (Matchett 1997). Only about 30 ferrets were known to survive from these releases. Since sylvatic plague has been detected among the prairie dogs on the Charles M. Russell Refuge, Fish and Wildlife Service biologists have attempted to control its spread by spraying flea power dust into burrows (Matchett 1997). Over 65,000 individual prairie dog burrows were dusted, a major undertaking which may prevent an outbreak that will decimate these animals, and extirpate the introduced Black-footed Ferrets (Matchett 1997). Only 10 percent of young survive their first winter after leaving their mothers, and habitat that is free of prairie dog control programs is extremely limited.

For the future, however, the number of potential release sites in prairie dog towns that are not being poisoned or bulldozed is limited, and funds for ferret breeding and release may dry up completely (Line 1997b). Federal biologists working on the ferret recovery program have expressed dismay at the lack of public interest in the return of these delightful animals to the wild and believe this will translate into a termination of the program (Line 1997b). The Fish and Wildlife Service hopes that one of the release sites, probably in South Dakota, may have self-sustaining

populations in the future, allowing capture of wild-born young for release elsewhere, rather than supplying captive-bred ferrets at great expense.

Both prairie dogs and Black-footed Ferrets could be major tourist attractions, adding to public knowledge about them and support for their conservation. Prairie dog towns provide constant interest as the little dogs chatter and hug and kiss one another in greeting. Other wildlife, from rare Burrowing Owls to hawks, snakes, tortoises, butterflies and some 170 species, find refuge there. Tourists would likely find the night spotlighting research of biologists studying the ferrets to be fascinating and often extremely lively.

America's largest bird, the California Condor (*Gymnogyps californianus*), once soared over the grasslands of the West, feeding on carrion. Centuries of persecution by hunters and egg collectors nearly caused the bird's extinction. In the 1980s, the last few birds were removed from the wild, where they were dying from accidental poisoning from lead shot in deer carcasses and strychnine from rodent-control programs. A captive-breeding program has been extremely successful, allowing for the release into the wild in southern California and near Arizona's Grand Canyon of young condors from the population of some 169 birds. With a 9.5-foot wingspan, these magnificent birds may again soar over wilderness areas of the West, but there have been problems with released birds approaching people™s homes and even entering them, colliding with power lines and ingesting lead shot. Release of adults, especially some of the original condors, to guide the young, which under natural conditions remain with their parents for several years, may be the only answer to a successful reintroduction.

Fifty-five grassland animals and plants are now listed as endangered or threatened species in the United States (West 1997). Grassland birds have declined more drastically than birds from any other habitat, according to studies by the Fish and Wildlife Service (Pruitt 1997). The wild and beautiful prairies and western shrubland have lost many species of plants, insects and vertebrates. Even where the land has not been plowed, but heavy grazing has occurred, species diversity has declined, and many exotic species of grasses have become established (Peck 1990). In fact, of all North America's grassland birds, only 10 percent have stable or growing populations, according to the North American Breeding Bird Survey (Line 1997). About 260 species of birds are known to breed in the Great Plains, of which 32 are endemic; settlement and agriculture had very adverse effects on most of these species (Knopf 1988). At least 13 species of native grassland birds exhibited downward trends in their populations between 1966 and 1995 (Line 1997). Many of these are among the most familiar and, until recent times, most abundant grassland birds. Meadowlarks, five species of sparrows, prairie chickens and several birds of prey are among these.

Even the bits and pieces of grassland that these birds and other grassland wildlife occupy are swept by pesticides, herbicides and other chemicals used by modern farmers. Crops planted in huge monocultures of one type only, such as corn, create an ecosystem lacking diversity. The introduction in the 1940s of chemical pesticides, fungicides and other chemicals for widespread use was heralded by chemical companies as the ultimate answer to insect and weed pests and a boon to mankind. Farmers wage constant battles on insects, but each year, more species of insects become immune to certain pesticides, and some insects have become immune to all known pesticides. Pesticides kill beneficial as well as pest insects, upsetting ecological balances. Many of the long-lived pesticides of the chlorinated hydrocarbon family, including DDT and dieldrin, enter water tables, persisting in the bodies of animals throughout the food chain. Annual pesticide application in the United States is estimated at 750 million pounds, while the percentage of crops lost to pests has increased from 7 percent in the 1940s to an estimated 37 percent today.

Bird kills began to be documented from DDT use in the late 1940s, and water birds suffered mortality and reproductive failure. DDT and its toxic relatives concentrate in aquatic plants, which are then consumed by small fish, and carnivorous fish accumulated extremely high doses. Birds of prey at the top of their food chains who fed on these

fish or waterfowl suffered complete reproductive failure, and several species, such as the Peregrine Falcon (*Falco peregrinus*) and the Bald Eagle (*Haliaeetus leucocephalus*), suffered population collapses in areas of high pesticide use.

Seventy percent of the United States grain production is fed to livestock; 45.5 million cattle are grazed in the Great Plains (Manning 1995). Many of them graze in the 19 grasslands of the National Grasslands system administered by the Forest Service, which encompass 1,600,000 hectares (3,953,600 acres); 17 are located on the Great Plains, and two are in the Far West (Knopf 1988). They are used primarily as grazing land for livestock, but native wildlife, including endangered species, persists there. The Bureau of Land Management (BLM) and the U.S. Forest Service's National Grasslands are the major landowners in these areas, and both operate under legislation which mandates multiple use or, according the needs of wildlife and conservation, an equal consideration with those of humans. The National Wildlife Refuge System also controls millions of acres of grasslands and drylands harboring endangered species. Livestock grazing and exploitation for oil and minerals takes place on these refuges and, in many cases, they have not been managed in such a way as to preserve natural habitats and threatened species.

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The United States has set aside sizeable portions of its deserts as national parks, national monuments and national wildlife refuges, as well as vast acreage administered by the Bureau of Land Management. Lands that are administered by the National Park Service as parks, preserves or monuments are far better preserved than the national wildlife refuges or the BLM land. Death Valley National Monument, for example, an enormous area in southern California, protects a huge area with its native vegetation, and the unique oases harboring endangered pupfish as well as other endangered species such as Bighorn Sheep (*Ovis canadensis*). Organ Pipe Cactus National Monument in Arizona and Big Bend National Park in west Texas protect endangered endemic cactuses and other rare species of the Sonoran Desert. Both are scenically breathtaking, with backdrops of jagged mountains. The newly created Mojave National Preserve in southern California covers 1.4 million acres and was the result of decades of lobbying to preserve this unique area. Some cattle grazing and some other types of potentially destructive activities will still be allowed (Wilkinson 1996), but they are gradually being phased out of this preserve, as well as Death Valley National Park (Wilkinson 2000).

Outside the protected areas, however, the Sonoran Desert, with its great diversity of flora and fauna, is gradually being destroyed by residential and urban development. The city of Phoenix, Arizona, for example, has grown dramatically, now numbering 1 million people and spreading more than 469 square miles (Egan 1996a). It is using up precious water reserves through diversion projects. One, the Central Arizona Project, diverted water from the Colorado and dried up other rivers where Bald Eagles (*Haliaeetus leucocephalus*) once nested, eliminating entire riparian ecosystems for the sake of the new city-dwellers and cotton agribusiness. Endemic cactuses fall to the bulldozer, and many wildlife species have become threatened by the new development. The *Arizona Republic* newspaper began a series, "An Acre an Hour," on the disappearance of the Sonoran Desert in 1993, and in the following three years, it documented the destruction of 25,000 acres of this fragile habitat (Egan 1996a).

Grazing is allowed at about 36 national parks and preserves, causing conflicts between wildlife conservation and private interests (Wilkinson 2000). Livestock is allowed to graze as a result of heavy pressure from western Congressmen (Wilkinson 2000). Riparian, or riverside environments, are crucial to the wildlife of these regions, and this type of habitat has been obliterated in hundreds of miles of western waterways after heavy trampling by cattle and sheep. Cottonwood and willow tree groves provide food and shelter for wildlife, and their shade cools the water for trout and other cold-water fish. These streamside trees should be zealously protected. The upper San Pedro River in south-central Arizona contains the largest surviving expanse of broadleaf riparian forest in the Southwest (Christensen 1999). It represents a beautiful oasis in surrounding desert, home to rare Willow Flycatchers (*Empidonax traillii*),

warblers, hawks, and kingfishers; a pair of beavers has been released into the river in the hopes that they would create a marshy pond of willow thickets that the flycatchers prefer. In spite of careful management of this first riparian national conservation area by the Bureau of Land Management, including fencing to keep cattle away, the entire habitat is drying up from over-pumping of water for nearby towns and an Army base (Christensen 1999). Cottonwoods and willows are already starting to die, and within the next decade, half the trees along the river are expected to die. Since Arizona does not regulate its water, which is cheap and available, there may be no way to keep this patch of green from disappearing.

At least eight state fish in the West are endangered as a result of grazing. Overall, grazing threatens some 340 species (Wilkinson 2000), and its effects are even more pronounced in land controlled by the Bureau of Land Management. Forest Service land is used to graze cattle and sheep as well, resulting in many battles between ranchers and environmentalists who try to limit the number of livestock or remove them altogether. Some ranchers are responding to the environmental complaints and are restoring damaged rangeland, allowing grassland to rest and providing alternate water supplies for livestock. New Mexico and Colorado have "grass bank" programs to restore grazing land, a program applauded by scientists as well as conservationists (Blakeslee 2000).

Some ranchers are uncooperative, however, and some environmental organizations believe that grazing is antithetical to proper range management and forest health (Blakeslee 2000). Two conservation organizations have sued to stop all grazing on public lands until federal officials can prove that endangered species are being protected from the destruction of their habitats (Blakeslee 2000). Over the past few decades, small-scale ranching has ceased to be profitable in spite of grazing fees set so low that the parks spend many times more money to maintain the grazing allotments than they receive in fees (Wilkinson 2000).

Ranchers have even received permission to erect fences within the borders of some national parks, blocking wildlife migration routes. The United States Congress is considering taking conservation easements on private ranchland adjoining national parks to protect wildlife in Grand Teton National Park (Wilkinson 2000).

When many of these parks were established, grazing was considered a legitimate use of the parks by Congress, and they were gazetted under these conditions. In spite of this, National Park Service personnel have been able to invoke various laws, including the Endangered Species Act and the National Environmental Policy Act, to force withdrawal of cattle; in some cases, ranchers are compensated for their allotments. The National Park Service is sponsoring a report on park grazing issues that may form the basis for a management policy to reestablish the parks in their primary purpose of protecting the land intact for future generations.

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One of the most characteristic birds of shortgrass prairie is the Greater Prairie Chicken (*Tympanuchus cupido*). These spectacular birds measure about 16 to 18 inches long, with elegant brown-and-white striated plumage. Males have a large yellow comb of bare skin above the eyes and, during a courtship display for the drab female, he expands bright yellowish-orange skin pouches or sacs on the sides of his neck and raises horn-like feathers on the top of his head, while stamping his feet. The pouches amplify his vocalizations, a series of booming calls; he simultaneously snaps his tail in fanning movements (Johnsgard 1983). Groups of male prairie chickens gather on bare ground, known as a "lek" area, and display for the benefit of females; males also "flutter-jump," leaping off the ground with wings spread out, often while whooping, cackling or issuing whining calls. Their courtship displays are among the most dramatic prairie spectacles. Greater Prairie Chickens have disappeared from the majority of their original range, with one subspecies extinct and two others highly endangered.

Attwater's Prairie Chicken (*Tympanuchus cupido attwateri*), native to coastal prairies of eastern Texas and

southwestern Louisiana, verges on extinction; in spite of recovery efforts that began in the 1970s, these birds total less than 68 in the wild (Anon. 1995). Historically, their population may have numbered 1 million birds in this region, but grasslands in this area have been destroyed by agriculture and development since the early 1900s. Efforts by the Fish and Wildlife Service to increase populations have included the establishment of Attwater's Prairie Chicken National Wildlife Refuge and, more recently, the 3,000-acre Galveston Bay Coastal Prairie Preserve in east Texas, which will be co-administered by the Fish and Wildlife Service and The Nature Conservancy (Anon. 1995). As recently as 1993, 456 Attwater's Prairie Chickens survived, but declines were noted at that time (Anon. 1993). Captive-breeding populations at four sites totaled 35 adults and 65 young in 1995, and some were released at the Attwater's Prairie Chicken National Wildlife Refuge.

The remaining subspecies of the Greater Prairie Chicken, *Tympanuchus cupido pinnatus*, is extinct, or nearly so, in 15 U.S. states and Canadian provinces, but legally hunted in four states. These birds suffered great declines in the past from market hunting, and hunting can decimate populations. In the 20th century, these birds lost much of their habitat to agriculture, and pesticides kill their chicks. Their distribution has become localized and fragmented, along with the undisturbed prairie which is their prime habitat.

Two grouse of the prairies have been listed as Special Concern by the National Audubon Society. The Sharp-tailed Grouse (*Tympanuchus phasianellus*), a close relative of the prairie chicken, resembles them except the male has a purple air sac in display and lacks the horn-like head feathers. This bird has a more northerly range than the latter species, living in brushy prairies, open bogs, or abandoned farmland from Illinois and Kansas north to Alaska (Farrand 1983). It has disappeared from much of the southern portion of its range as a result of overhunting, overgrazing, and conversion of native grasslands to agriculture (Ehrlich *et al*. 1992).

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Sage-juniper shrubland once covered much of many western states in a north-south band from southern Canada to Mexico. This habitat made optimum use of the low rainfall of the region while sheltering an array of wildlife. Pronghorn antelope, deer, foxes, jackrabbits, Coyotes and a great variety of small mammals, birds and reptiles were native. The Bureau of Land Management and private ranchers acquired much of this region and attempted to turn it into grazing land. To eradicate the native plants, herbicides were used, and in many areas, the vegetation was chained: Battleship anchor chains strung between bulldozers are dragged through the sage and other native plants, pulling them out by their roots and leaving bare earth. This eliminated large portions of this habitat, threatening a host of native species. Chaining has been opposed by conservationists and Native Americans, but little action was taken until a 1997 lawsuit by the Paiute Indian Tribe of Utah and the Southern Utah Wilderness Alliance halted work in the area. The tribe claimed that chaining disturbed archeological sites, and the conservation group opposed it on environmental grounds. Chaining continues in Utah and elsewhere. The destruction of sage-juniper shrubland has allowed an invasion of exotic weeds, from tumbleweed to Eurasian Cheatgrass (*Bromus tectorum*), an extremely flammable plant that has spread over an estimated 100 million acres across the West. Native wildlife, such as Mule Deer, Sage Grouse and jackrabbits, which thrive in sagebrush, disappear when Cheatgrass takes over. Cheatgrass does not provide good forage for livestock because it is green only briefly in the spring and fall. Massive rangeland fires have broken out, scorching the ground and bringing about the collapse of entire ecosystems, according to Jayne Belnap, an ecologist with the U.S. Geological Survey. Herbicides are being used to eradicate Cheatgrass with varying success, and a fungus may be introduced which kills the grass. Federal officials are attempting to restore native plants and grasses to portions of Utah to replace Cheatgrass and other exotic weeds such as Russian knapweed. Restoration of the original sage-juniper habitat may never occur, however.

One species that has suffered from loss of sagebrush habitat is the Sage Grouse (*Centrocercus urophasianus*), the largest grouse in North America. Weighing from 5 to 7 pounds, this bird is native to sage rangelands from southern

Saskatchewan south to Utah, Colorado and eastern California. The displaying male expands large white air sacs which are surrounded by a huge mass of fluffy white feathers encircling his head and covering his belly, making him look double his actual size. He folds his dark brown wings to frame the white chest plumage and spreads his brown spotted tail in a fan of long spikes. While displaying, the male makes a bubbling sound as air is released from his air sacs, and the female, in sombre brown and white plumage, cackles (Farrand 1983). Millions of acres of this spectacular bird's habitat have been converted to agriculture and grazing. Sagebrush, which comprises this species' entire diet, has been destroyed to create grazing land for cattle (Ehrlich *et al*. 1992). Western populations of the Sage Grouse may be listed on the Endangered Species Act, having been officially classified as a Category 2 species by the Fish and Wildlife Service, indicating a species that may be in jeopardy unless current trends are reversed. The full species has been listed by the National Audubon Society as a bird of "Special Concern" (Ehrlich *et al*. 1992). The Sage Grouse is extinct in British Columbia and New Mexico (Farrand 1983).

The destruction of sage shrubland did not result in seas of grass for cattle because of the climate and soil factors. Instead of forage, exotic grasses took hold, and today the Bureau of Land Management claims that one of these, the Eurasian weed cheatgrass (*Bromus tectorum*), has become the foremost environmental problem in the country. It has infested an estimated 100 million acres of what was once sage and native grasses. The BLM itself laid the way for this invasive weed, which is extremely flammable and spreads in uncontrolled wildfire once ignited. The United States government is planning to introduce a fungus native to Eurasia that kills the grass, and other scientists are testing an herbicide to kill it. Cheatgrass does not provide good forage for livestock because it is green only briefly in the spring and fall. Ranges that burned only once a century now catch fire every three or four, and cheatgrass has come to dominate the ecosystem. Some research scientists are cultivating native grasses in laboratories to replace cheatgrass. Chaining is planned to rid the range of cheatgrass.

West of the Rocky Mountains, large stretches of prairie, known as intermountain grasslands, occur from eastern Washington through Nevada and Utah. Only 1 percent or less of California's grasslands remain (Mittermeier *et al*. 1999). Once they covered 9 million hectares (more than 22 million acres), dominating the Sacramento and San Joaquin valleys, known as the Central Valley (Mittermeier *et al*. 1999). This valley is now almost entirely agricultural fields, livestock grazing area and urban development. Many species of plants and animals were probably lost since these grasslands were plowed before botanical and zoological studies were made (Knopf 1988). The vernal pools, or temporary wetlands, that once provided habitat for wildlife, including spawning places for turtles and frogs, are also nearly gone (Mittermeier *et al*. 1999).

In California's southwestern coastal region, a unique mosaic of ecosystems of sage giving way in parts to oak woodlands, dunes, conifers and riparian vegetation, once covered millions of acres (Boucher 1995). This natural environment is under extreme threat from development by the burgeoning populations of San Diego and a string of towns and cities that stud the coast and inland areas north to Los Angeles. Unrestricted building of homes, golf courses, highways and industries have consumed hundreds of thousands of acres here since the 1970s. The areas along river and streams, or riparian regions, are the most endangered habitats. The virtual explosion of development has squeezed wildlife into pockets of their original ranges and threatened the survival of hundreds of species.

The Fish and Wildlife Service lists 77 species of animals and plants that are dependent on the coastal sage ecosystem on the Endangered Species Act, and almost 400 more species as candidates (Mann and Plummer 1995). Among these is the California Gnatcatcher (*Polioptila californica*), a small black-capped songbird, first listed on the U.S. Endangered Species Act as Threatened in 1993 after the State of California bowed to developers and refused to list it on the state endangered legislation. The statewide population totals only a few thousand birds. Another endangered bird, Least Bell's Vireo (*Vireo bellii pusillus*), is restricted to shrub and scattered woodlands in this same region. The state of California has listed many other threatened resident species of the region, halting many developments. Since this is some of the most valuable real estate in the country, with real estate lots selling for between $200,000 and $3 million an acre, conflicts arose (Mann and Plummer 1995). The human population of Southern California quintupled between 1940 and 1995, a rate that exceeded Bangladesh's rate of increase (Mann and Plummer 1995). A consortium of 40 California conservation groups fought to save these songbirds and their habitat

and, in the process, curb the smog, traffic, pollution and housing developments that are taking over the state.

The high-pitched battle included developers, the business community, residents, local and state legislators, federal government authorities, conservationists and scientists, all at odds over the fate of this beautiful region and its wildlife. The coastal sage shrub ecosystem has been reduced to about 6,000 square miles of disconnected patches south of Los Angeles, with one of the largest preserved areas being the U.S. Marine Corps' Camp Pendleton (Mann and Plummer 1995). The California Resources Agency chose this habitat to test its Natural Communities Conservation Planning (NCCP) program, dividing it into 13 subregions; the city of San Diego had its own program to cover 12 habitat types over 900 square miles (Mann and Plummer 1995).

A complex alliance of organizations and interests finally agreed to a federal-state master plan for the conservation of two counties, with the objective of preserving the major part of what remains of the already fragmented ecosystem. Although far preferable to uncontrolled development, the Endangered Species Act's Habitat Conservation Plan (HCP) for San Diego and Riverside counties allowed massive growth of housing and highways to occur in endangered species habitat. Because the California Gnatcatcher is listed as Threatened under the Endangered Species Act rather than the more restrictive category of Endangered, development can continue under Fish and Wildlife Service regulations, which allow up to 5 percent of its coastal sage shrub habitat to be destroyed (Boucher 1995). Also, the listing of this bird had been conditional, based on the success of the NCCP plan under an obscure rule of the Endangered Species Act (Boucher 1995). The plan created a system of large protected reserves linked with corridors of similar habitat. Developers can build on habitat outside the reserves. The sizes of the reserves, which also include habitats of some or all of about 80 additional species threatened with extinction, are critically important. Scientists appointed to some review panels for the HCPs have found that, rather than producing specific guidelines, they were asked only for general ones, and considering that 90 percent of the coastal sage shrub has already been destroyed, there is little room for error. In Orange County, development companies own the majority of sage shrub, and their consultants have demanded that scientists prove their case concerning the amount of area needed for reserves, causing one environmentalist to conclude, "The county is the lead agency in name only. It's basically a branch of the real-estate industry there" (Boucher 1995).

In spite of the apparent success of some of these agreements, some scientists have expressed uncertainty as to whether the reserves will be adequate to prevent extinction of the California Gnatcatcher and other species (Boucher 1995). These conflicts are occurring in other parts of the country as well, pitting environmentalists against developers. Unless the careening, out-of-control development and the geometric population growth slow, thousands of species and their unique habitats will be lost in the process, no matter how careful the planning.

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Kangaroo rats are other species caught up in land battles. Native to shrub and desertland in the Southwest and Far West, several species are highly endangered. Their name might conjure up images of enormous, menacing rodents, but these little animals are, in fact, very attractive, with huge dark eyes. They have been named for their jumping ability. Ranging from 4 to almost 8 inches, depending on the species, they have long tails, equal in length to their body, ending in fluffy tufts (Nowak 1999). Weighing only between 1.2 to 6.3 ounces (35-180 grams), they are able to leap almost 7 feet on their outsized hindlegs (Nowak 1999).

A recent acoustical research study found that kangaroo rats communicate various messages, such as danger, by drumming their feet on the ground in different cadences. Twenty-one species of kangaroo rats occur in North America, living in colonies in shrublands and shortgrass prairies (Nowak 1999). Four species and subspecies of kangaroo rats live in California's San Joaquin Valley, north of Los Angeles, and each has lost at least 95 percent of its original habitat to agriculture and urbanization; all of the latter have been listed on the Endangered Species Act

(Nowak 1999). The original range of the Tipton Kangaroo Rat (*Dipodomys niatoides nitratoides*), a terrain of iodinebush, saltbush, Red Sage and other shrub plants, once covered nearly 2 million acres of the southern San Joaquin Valley, but today, only 1 percent of this rodent's population remains, almost all in the 4,000-acre LoKern Preserve, which protects a last remnant of this habitat. The Giant Kangaroo Rat (*Dipodomys ingens*), another endangered species of this valley, is the largest of all kangaroo rats; a population of this species lives in the LoKern Preserve (Peterson 1993). The Giant Kangaroo Rat is considered the most endangered of all kangaroo rats, classified as Critical by the *1996 IUCN Red List Animals* (Baillie and Groombridge 1996). This status designation is accorded to species in imminent danger of extinction. Kangaroo rats are extremely vulnerable to poisoning programs aimed at ground squirrels, and without reserves where poisoning is banned, they have disappeared.

Kit Foxes (*Vulpes macrotis*) are now rare throughout their range in the West, and one subspecies, the San Joaquin Kit Fox (*Vulpes macrotis mutica*), is listed on the U.S. Endangered Species Act as Endangered. Only 2,000 to 6,000 animals remain (Begley 1997). Some of these tiny foxes live in reserves, while others survive on the outskirts of cities built on their original habitat. Bakersfield, California is an urban area where a small and beleaguered population of these little foxes survives. Weighing only 5 pounds, the kit foxes in Bakersfield make their dens in vacant city lots, vulnerable to injury from broken glass and predation by dogs (Begley 1997). Cars and trucks kill and injure them. One lame Kit Fox with an injured back leg was given handouts of doughnuts and scraps by a night shift mechanic at a city maintenance yard until the animal was struck and killed by a vehicle (Begley 1997). In a bizarre accident, two kit foxes died after becoming entangled in soccer nets at California State University (Begley 1997).

San Joaquin Kit Foxes are also illegally shot for sport and poisoned by ranchers in the mistaken idea that they pose threats. They have been forced into the last vestiges of their once vast range, which becomes smaller each year. Construction crews have bulldozed them in their dens, and pairs, who mate for life, have been forced into unnatural habitats, digging dens beneath fuel storage tanks and in other exposed areas (Begley 1997). They have natural enemies as well, preyed upon by Coyotes and eagles. A recent escapee from fur farms, the eastern Red Fox, now roams the San Joaquin Valley and occasionally kills these little foxes (Begley 1997). Few of their 1-pound pups survive to adulthood. Only in the Carrizo Plain and portions of western Kern County do sizeable pieces of habitat remain. In all, they have lost over three-fourths of their original habitat, and these graceful, agile little foxes may disappear unless efforts are made to link fragmented populations and set aside more habitat.

This fox became a pawn in the battle over the U.S. Endangered Species Act, which has pitted commercial interests against conservationists. Congressman Richard Pombo, a California Republican, proposed legislation in 1994 to replace the Endangered Species Act. It would have made species preservation an optional matter to be weighed against potential economic losses that could result if the habitat were set aside, and would have required the federal government to pay property owners for the value lost on land subject to restrictions on behalf of endangered species. Congressman Pombo's district, the San Joaquin Valley, has very little undeveloped land left, and the land value has escalated. His family owns a large real estate firm which has profited from the land boom in the valley. San Joaquin Kit Foxes inhabit the ranch next door to Congressman Pombo, and his neighbor, Mark Connolly, does not share his views. Mr. Connolly likes open space as well as the foxes, and he sold the development rights on his property to a nature conservation organization, allowing him to protect the foxes along with the land (Egan 1996b). Congressman Pombo's proposed legislation, which fortunately, did not become law, would not have given special protection for the remaining San Joaquin Kit Foxes in his district without massive infusion of public money to repay landowners.

Private organizations, such as The Nature Conservancy, have been acquiring millions of acres of grassland and desert to protect endangered habitat. Educational programs on the importance of saving grassland and desert habitats and returning them to their original states will increase in the future as governmental entities and private organizations produce more publications, films and other materials. Students are also becoming involved in preserving these habitats by propagating the seeds of rare plants and restoring degraded prairie. American deserts are among the most stunning and colorful in the world, yet they are the subject of fewer conservation projects and educational publications than grasslands. They are under assault from developers, miners, livestock and highway builders. A growing number of conservationists are defending them, however, and designation of new national parks in the deserts of Utah and

southern California stopped planned developments and mining.

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So thorough has been the destruction of eastern savannah that reestablishing the native species has involved a detective investigation of early natural history documents. Conservationist Steve Packard found old botanical references on Illinois' native plants and gradually pieced together what species must have once lived in Vestal Grove; he then set about to find seeds, especially of rare plants that were threatened with extinction (Stevens 1995). Botanists and volunteers from the Sierra Club and The Nature Conservancy scoured the few places not plowed or developed still harboring rare Illinois prairie plants-- strips of land next to railroads, for example (Stevens 1995). Remarkably, many rare plants have been found, their seeds obtained, and, after long trial and error, methods of restoring this ecosystem developed. Controlled fires need to be set annually to burn off some types of aggressive shrubs. Before they were driven from the land, Native Americans lit these fires to maintain grasslands. This project is part of a far more ambitious plan in which 3,000 volunteers will replant 17,000 acres of tallgrass savannah on 142 sites in the Chicago area; ultimately, 100,000 acres will be restored, as described in *Miracle Under the Oaks*, a book by William K. Stevens (1995).

In another area near Chicago, the Forest Service has established the Midewin National Tallgrass Prairie on the site of the former Joliet Army Ammunition Plant; 5,000 acres will be restored to native grasses and wildflowers, and Elk and American Bison will be reintroduced (Line 1997).

The Fish and Wildlife Service is participating in a project to restore some 77,000 acres of grasslands in 85 counties of western Minnesota and northwestern Iowa, designated as the Northern Tallgrass Prairie Habitat Preservation Area (West 1997). In Minnesota and Iowa, less than 1 percent of the original 25 million acres of this habitat remains (West 1997). The project will involve individuals, organizations and various state and county governments as well, all working to restore the biological diversity and plants of these grasslands.

North Dakota, likewise, has less than 1 percent of its original tallgrass prairie. Parcels that remain are being acquired by the Department of the Interior, and some damaged land is being restored. A federally listed threatened flower, the exquisite Western Prairie Fringed Orchid (*Platanthera praeclara*), has a population in the Sheyenne National Grassland in southeastern North Dakota. Managed by the Custer National Forest under a conservation plan, its habitat is being preserved (Sieg 1997). This plant, although once widespread through the tallgrass prairie west of the Mississippi River, has become reduced to two main populations, one of which is the Sheyenne National Grassland. These orchids do not flower every year, but when they do, the white fringed flowers produce a fragrance that attracts hawkmoths that come at night to pollinate it (Sieg 1997). The species' life history is poorly understood, and efforts to germinate its seeds in greenhouse conditions have not been successful. Botanists suspect that a fungus might be needed to promote absorption of nutrients for germination, and it seems to require unusual conditions of soil moisture (Sieg 1997). These orchids live at least 10 years, and study is proceeding on individually marked plants to learn more about their ecology. In addition to loss of habitat, the plant is threatened by a noxious weed, Leafy Spurge (*Euphorbia esula*), which is spreading within its limited range(Sieg 1997).

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Contamination of water and soil in the United States Midwest is a growing problem. A major reason for the continued high use of pesticides is the planting of hybrid seeds bred to produce high yields. First introduced in the 1960s and 1970s, these seeds were touted as bringing about a "Green Revolution" which would feed the world. Massive applications of petroleum-based nitrogen fertilizers, toxic herbicides, insecticides and fungicides are required

to grow these weakened, seed-heavy plants (Ehrenfeld 1997). The costs of these chemicals and the giant machines needed to sow, apply pesticides and reap crops are so prohibitive that farmers become indebted, often losing their farms when crops fail (Ehrenfeld 1997). Green Revolution programs started and failed in many Third World countries, yet are still widespread. India, southeastern Asian countries and many Latin American nations experienced high yields at first, which later dropped, and incurred heavy debts from both the cost of the seed and the chemicals needed to grow these crops.

A more recent approach to insect and weed pests is the creation of genetically engineered versions of crop plants to resist certain diseases and pests. Genes from one plant resistant to disease are implanted in another, with only the disease-resistance trait passing on in theory. In practice, genes have many traits with the potential of being introduced, creating a plant with uncontrollable characteristics that might become established in the wild, overwhelming native plants (Ehrenfeld 1997). Genetically engineered versions of many food plants are grown on millions of acres in the United States. Some of these genetically engineered seeds have been implanted with the genes of animals, including fish, to impart various qualities such as resistance to cold (Feder 2000). The dangers of such manipulations are great, and many biologists have expressed serious reservations about these new man-made creations. *The Last Harvest. The Genetic Gamble That Threatens to Destroy American Agriculture* (Raeburn 1995) examines the potential threats.

One dangerous trend in genetic engineering of crop plants is the development of soybeans and other crop plants that are immune to the effects of herbicides, encouraging farmers to broadcast large amounts of these toxic chemicals, which are associated with human illness, including lymphoma (Ehrenfeld 1997). A leader in bio-engineering of crop plants is Monsanto, which also manufactures the herbicide Roundup, a product that has experienced unprecedented high sales in recent years due to the growth in sales of genetically engineered seeds. Rutgers University biology professor, David Ehrenfeld (1997), considers the genetic engineering trend to be a "Techno-pox upon the Land," whose approach ignores the "great complexity of living organisms and the consequences of tampering with them." Monsanto has funded a center at the famed Missouri Botanical Garden for research, which has angered many who are opposed to both genetic engineering and the toxic agricultural chemicals (Jackson 1998). For many Americans and the majority of Western Europeans, food produced in this manner is "Frankenfood" or Frankenstein-like creations that might harm people as well as the environment. Although European countries and many U.S. food processors reject genetically engineered grains, their use, as well as other crops with genes implanted from a wide variety of organisms from nuts to trout, is widespread in hundreds of products. Other countries, such as China, are eagerly introducing bioengineered crops.

Genetically engineered crops also present dangers to wild plants and animals, many of which are endangered, living in remnant prairies, roadsides and pastures. These areas provide vital habitat and feeding grounds for grassland birds, butterflies and other wildlife. Many bioengineered crops containing pesticide genes threaten these prairie vestiges. Monarch Butterflies are the most familiar butterflies in North America, ranging throughout the continent, their black-and-orange wings brightening gardens and fields as they migrate in spring and fall. Scientists recently found, however, that genetically engineered corn implanted with Bt, thought to be a fairly benign and natural pesticide, could spread pollen that was toxic to these beautiful butterflies and other beneficial insects (Feder 2000). Although conservationists and organic food advocates have campaigned against the use of this corn, the highly profitable bioengineering industry fought back with studies that concluded that the corn was not a threat to the butterflies. The United States government has no laws governing the effects on the environment of such crops, or even extensive field testing, prior to their use.

Far more ecologically benign is organic farming. Using natural fertilizers such as manure and plant material, rotating crops to enrich the soil and enhancing habitat for natural pest controllers, including birds and predatory insects, are all age-old farming methods. Those farmers who have used these methods have kept land fertile and yields high indefinitely. Within the past few decades, the pendulum has begun to swing away from synthetic pesticides, herbicides and fertilizers back to the natural approach to farming in the United States and elsewhere in the world. More and more American farms are returning to this method. Sales of organic food are rising in the United

States at a phenomenal rate, fed by a market willing to pay more for chemical-free food. This farming does not contaminate ground water, eliminate native plants and invertebrates with herbicides and fungicides, or kill wildlife with pesticides.

Drylands of the World: SOUTH AMERICA

The majority of South America's grasslands, from low altitudes to Andean meadows, have suffered desertification from livestock similar to that seen in other parts of the world. Agriculture has taken over large portions of tropical grasslands. Brazil's Emas National Park is an ecological island covering 131,868 hectares (325,846 acres) of grassland with some gallery and dry forest in the center of thousands of square miles of cultivated grain fields. This vestige of the original Brazilian grasslands has a rich variety of birds and several endangered mammals, including Giant Anteaters (*Myrmecophaga tridactyla*) and the beautiful Maned Wolf (*Chrysocyon brachyurus*). The once widespread grasslands of the region is threatened by pesticide use, erosion and other destructive practices in surrounding plantations. Conservation International and a local environmental group working to protect the Emas are attempting to reduce these threats and develop environmental education and ecotourism in this park (Fonseca *et al*. 1999). This park and its wildlife are seen in fiEmas: High Plains of Brazil,fl a 1985 film that shows many of the endangered species; aerial views show the island-like isolation of this national park (see Video, Regional, Latin America).

The endangered Maned Wolf was formerly widespread on the savannahs, northern pampas and chaco regions of central and eastern Brazil, Argentina and Uruguay (Nowak 1999). This longer-legged canid is designed to hunt in the savannah, able to peer high above the tall grass for rodents, birds, frogs and insects; it also feeds on fruit, especially that of a shrub known as *fructa de lobo (Solanum grandiflorum*), a member of the potato family (Dorst 1967). Its head and body are about 4 feet long, with shoulder height of 2.4 feet, making it a fairly large animal, but it weighs only 20 to 23 kilograms (44-50.6 lbs) (Nowak 1999). Looking somewhat like a Red Fox on stilts, its stick-like black legs contrast with long, shaggy, reddish-yellow body fur. The fur on its back and nape stands up stiffly, giving it the appearance of a large and stocky animal, while in reality, it is slight and wiry. The Maned Wolf does not closely resemble any other canid, and has been placed in a genus of its own. These wolves have been killed and persecuted under the false impression that they are a threat to livestock and have suffered from habitat loss, the annual burning of grasslands and live capture for zoos. Classified as Near-threatened by the IUCN (Baillie and Groombridge 1996), the Maned Wolf is Endangered on the U.S. Endangered Species Act, and on Appendix I of CITES.

Native deer of three species inhabit South America's grassland, wet savannah and shrub woodland. Two of these have become endangered by loss of their natural habitats to livestock, agriculture and overhunting. Pampas Deer (*Ozotoceros bezoarticus*) were once abundant in grasslands from southern Brazil to eastern Bolivia, Paraguay, Uruguay and northern and central Argentina (Nowak 1999). In spite of an enormous original distribution, these deer have undergone steep declines and now survive only in tiny remnants of their range. The species has been listed on Appendix I of CITES and as Endangered on the U.S. Endangered Species Act. Three subspecies of the Pampas Deer are listed in the *1996 IUCN Red List Animals* (Baillie and Groombridge 1996). These lovely deer inhabit a wide variety of grassland habitats, all at low elevations, including flood plains, rolling hills and grass tall enough to completely conceal a standing deer (Nowak 1999). Four hundred years ago, before the arrival of Europeans, these deer were abundant, especially on the pampas of Argentina and Uruguay (Nowak 1999). Native Indians had a relationship with the Pampas Deer similar to that of the Plains Indians with the American Bison in North America, relying on it for their livelihood. The Indians were expert horsemen who hunted the deer for subsistence purposes, but when Europeans settled, they killed them for commercial trade (Nowak 1999). More than 2 million skins were exported in the decade 1860-70 from Argentina, and others were taken in neighboring countries (Thornback and Jenkins 1982).

In spite of this slaughter, Pampas Deer remained widespread until the grasslands were settled. Cattle, sheep, exotic Sika and Fallow Deer, and European Hare were introduced, and the land was plowed for crops (Thornback and Jenkins 1982). Domestic livestock transmitted disease to the deer, further decimating them, and hunting continued in an uncontrolled manner (Nowak 1999). In Argentina, only a few remnant herds survive, totaling about 500 animals (Nowak 1999), while the population in southeastern Brazil is nearly extinct (Rizzini *et al*. 1988). In Uruguay only about 1,000 Pampas Deer remain in nine isolated sites (Nowak 1999). Populations in central Brazil, Bolivia, Paraguay and part of northern Argentina are low and declining (Nowak 1999).

The Cerrado of eastern Brazil is a wilderness of savannah, woodland/savannah and dry forest. Until recently, it had not been recognized for its biological wealth, either internationally or by the government of Brazil (Mittermeier *et al*. 1999). Now it is receiving the attention of conservation organizations within Brazil and has been a focus of the recent book, *Hotspots* (Mittermeier *et al*. 1999), describing these high-diversity areas. Action is being taken to preserve portions of this area, home to a wide variety of unusual plants and animals. The Private Natural Heritage Reserve system is similar to the conservation easements, or agreements not to develop land, that have been taken on privately owned land in the United States. Private conservation organizations in Brazil, especially FUNATURA, have been active in establishing these areas in the Cerrado, and to date over 20 of these wildlife sanctuaries have been established (Fonseca *et al*. 1999). Such land can receive tax deductions and legal protection provided by the Brazilian state. A book on the biology and wildlife of the area was published in 1993 (Pinto 1993), and in 1995, a major conference was convened on the conservation of the Cerrado and Pantanal, drawing 215 experts from Brazil and international participants (Fonseca *et al*. 1999). It identified 70 priority areas within the Cerrado for conservation and made suggestions for legislation to create incentives to preserve biodiversity and the environment (Fonseca *et al*. 1999).

A large national park was established in the Cerrado in 1989 covering 84,000 hectares (207,564 acres) of a 13-million-hectare region along the Sao Francisco River threatened by agricultural plantations and charcoal production (Fonseca *et al*. 1999). It is the first and only debt-for-nature swap ever approved for Brazil, signed by FUNATURA and The Nature Conservancy, providing some $2 million in government bonds whose interest would fund conservation within the park over the next 20 years (Fonseca *et al*. 1999).

Drylands of the World: SOUTH AMERICA: Atacama Desert

Patagonia, a vast wilderness of grasslands, shrub and desert, is home to a diverse array of unique animals, from endangered members of the camel family to deer and large rodents. Over the past few hundred years, this wildlife has been displaced by livestock, which are overgrazing and desertifying the region. The Guanaco (*Lama guanaco*), a wild relative of the domestic Llama, was once the characteristic animal of Patagonia's grasslands in populations estimated at between 30 and 50 million prior to the arrival of Europeans (Nowak 1999). In the past 400 years, they have been crowded out of prime habitat by the millions of sheep grazed by ranchers. Only about 571,000 Guanacos survive, and their numbers continue to decline (Nowak 1999). In some areas, ranchers kill Guanacos, considering them competitors with sheep for grass. The species has been eliminated from most of eastern and lowland grasslands, from southern Peru to eastern Argentina south to Tierra del Fuego (Nowak 1999). In their vast Patagonian range, no large protected areas have been set aside for them (Uhart and Baldi 2000). One of the few places where one can see these statuesque animals in Argentine Patagonia is the 2,500-acre Cabo Dos Bahias Provincial Reserve on the coast; it is surrounded by ranch land used for sheep grazing (Uhart and Baldi 2000). In the summer of 2000, 350 to 500 Guanacos were found dead in this small reserve, including entire families with newborn young. A team of veterinarians from the Wildlife Conservation Society (WCS) flew from New York to determine the cause (Uhart and Baldi 2000). Preliminary examination of carcasses indicated that the Guanacos had slowly starved to death as a result of being confined to a too-small reserve that was poorly managed and allowed to become overgrazed and desertified; managers had even allowed sheep to graze within the reserve (Uhart and Baldi 2000). WCS urgently recommended

that the reserve be enlarged.

Guanaco family groups are headed by a male who leads four to ten females and young under 15 months (Nowak 1999). At certain times of the year, groups form herds that may number as many as 100 animals (Dorst 1967). Males act as sentinels and warn of danger, allowing the herd to escape at high speed, up to 56 km per hour, outrunning a man on horseback (Dorst 1967). Guanacos are listed on Appendix II of CITES, since their pelt and fur are in commercial demand.

Its close relative, the graceful and beautiful Vicuña (*Vicugna vicugna*), inhabits hill and steppe grasslands at high altitudes of the Andes in Peru, Bolivia, northwestern Argentina and northern Chile (Nowak 1999). Heavily hunted for its extremely valuable fur, it nearly became extinct several times during the 20th century. The Incan people had traditionally captured Vicuñas alive, shearing them for their wool and releasing them. Prior to the arrival of the Spanish, these animals numbered an estimated 1 to 1.5 million (Nowak 1999). From the 17th century onward, the Spanish killed them by the hundreds of thousands, replacing them with domestic livestock in much of their original range. By the 1950s, only 400,000 Vicunas remained, declining to only 6,000 in 1965 (Nowak 1999). Since then, conservation measures have brought them back to about 200,000. Herds are rounded up under current laws, and their wool is sheared. The soft wool is marketed on a quota basis under CITES regulations from several countries, primarily Peru, but some illegal killing occurs (see Trade chapter). The populations of Vicuña need to be guarded very carefully to prevent further decimation of their numbers.

The Chaco, a mixed savannah-woodland region of Paraguay, Bolivia and Argentina, covers 100,000 square miles wedged between the Pantanal wetlands of southern Brazil, the semi-tropical forests of eastern Paraguay, the Argentine pampas and the Andes to the west. Prior to the arrival of Europeans, the grasslands were maintained by native peoples who burned vegetation periodically, limiting woodland growth (Bucher and Nores 1988). Ranches were allocated to European immigrants by the governments of Paraguay and Argentina, and the new immigrants cut woodlands and plowed the grassland for agriculture. This region, once a wildlife paradise with more mammal species per square mile than the Amazon basin, according to some zoologists' estimates, has become ravaged by misuse (Thigpen 1996). More than 400 species of birds were native to the thorny brushlands, marshes, forests of ancient oaks, grasslands and deserts (Thigpen 1996).

In Argentina and portions of Paraguay, overgrazing by livestock has turned savannah into shrub, and agriculture has destroyed more of the Chacoan ecosystem. This has threatened many species of native wildlife. The few parks in the region lack adequate staffing to prevent destruction by activities such as illegal grazing. In recent decades, bird trappers have felled tens of thousands of old oaks and other trees, used by Blue-fronted Amazons (*Amazona aestiva*) for nesting, in order to obtain the young chicks for the pet trade. This trade was ended in the early 1990s after undercover investigations and films by the Environmental Investigation Agency documented this cruel and destructive trade, and the United States banned importation of these birds. Public opinion and the catastrophic decline in wild populations of these parrots forced the Argentine government to stop exports, but in many areas of Argentina, old trees with nesting cavities have now disappeared. Forests have also been felled to make way for agriculture, which has threatened many kinds of parrots and other hole-nesting birds, such as woodpeckers and the Great Horned Owl (*Bubo virginianus*) (Bucher and Nores 1988). Eucalyptus has been planted in many parts of the Argentine Chaco, and this exotic tree has had a deleterious effect on native plants and wildlife.

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The Sahara Desert represents an extreme case of grassland destruction by humans. African Elephants (*Loxodonta africana*) lived in the Central Saharan highlands 10,000 years ago, and until 6,000 years ago, much of the Sahara was a vast grassland, interspersed with lakes and rivers. People inhabiting this region at that time recorded the wildlife in paintings on mountainous cliff faces and on cave walls. Massive petroglyphs of larger-than-life-size Giraffes (*Giraffa camelopardalis*) have been found in Niger's Sahara (Clottes 1999). The male Giraffe is almost 20 feet long in a striking, deep engraving delineating each patterned blotch, crafted some 8,000 years ago (Clottes 1999). Drawings of antelope, ibex, Brown Bears (*Ursus arctos*), Lions, Cheetahs, elephants, gazelles and Black (*Diceros bicornis*) and White Rhinoceroses (*Ceratotherium simum*) froze in time an environment that gradually vanished. Five thousand years ago, Egyptians began cultivating grasslands for crops, overhunting wildlife and draining marshland bordering the Nile for agriculture (Ponting 1991). Ancient Egyptian paintings show the panorama of wildlife that once flourished in the grasslands and marshes in the Nile River region. Large and small wild cats were common, as were Giraffes, rhinoceroses, Hippopotamuses (*Hippopotamus amphibius*) and other large mammals. By the Old Kingdom period (2950-2350 B.C.), the African Elephant, rhinoceroses and Giraffes had disappeared from the Nile Valley (Ponting 1991). The Cheetah disappeared from northeastern Africa at an early period. These graceful cats had been domesticated by the Egyptians and appeared in their paintings, but were gradually killed off or over-captured in the wild. Misuse of the land, which ended in turning grasslands into sand dunes and destroying the fertility of the seasonal flood plains and marshes, was the major cause of the demise of the Egyptian civilization (Ponting 1991). Desert sands have interred many of the monuments and pyramids of this once flourishing culture.

Following the decline of the Egyptian civilization, the Sahara became a crossroads of nomadic peoples and their livestock. Over the centuries, grasslands turned to shrub and isolated patches of vegetation from overgrazing, resulting in a drying of the climate and a decline in large mammals. Sand dunes now dominate this enormous region, and the majority of grassland species have been eliminated. Only those animals able to subsist in extreme heat and desert-like conditions survive here today, and even these have been restricted to the few remaining pockets of vegetation and near oases. These green spots in the Sahara are fed by springs and were once havens for wildlife and plants. Humans have gradually taken them over for livestock, agriculture and human habitation. Until recently, camels transported salt across the Sahara, traveling in caravans of as many as 20,000, which required vast amounts of vegetation for fodder. Nomadic tribes such as the Tuareg continue to herd large flocks of sheep and goats consuming what vegetation manages to survive in this arid environment. Shrubs and trees are cut for firewood, further desertifying the region. During the 1970s and 1980s, severe droughts and an expanding desert resulted in the deaths of many domestic camels (Onishi 2001). As a result of desertification and consequent loss of vegetation, especially in Niger and Mali, many of these nomads are finally giving up their lifestyle and becoming farmers near oases (Onishi 2001).

During the 20th century, Saharan wildlife came under intensified pressure from increased numbers of livestock and hunting from all-terrain vehicles equipped with machine guns (see Persecution and Hunting chapter). By the 1970s, virtually all large ungulates had become endangered or disappeared altogether. Smaller species, such as gazelles, became rare.

Deterioration of the Sahara during the 20th century resulted in the expansion of its boundaries by about 250,000

square miles along its southern edge between 1925 and 1975; in parts of the Sudan, the desert boundary moved south by 120 miles in the years from 1958 to 1975 (Ponting 1991). The Sahara now covers an area equal to that of the United States, or 8 percent of the land area on the planet. Lacking vegetation other than on the far-flung oases, the landscape is marked by dune fields, gravel plains, rocky plateaus with deep gorges and stark mountains (Allan and Warren 1993).

Scimitar-horned Oryx (*Oryx dammah*) originally lived in arid grasslands from Morocco and Senegal east to Egypt and the Sudan, an immense range. In historic times, herds of 100 animals were commonly seen, increasing to 1,000 or more during wet season migrations (Nowak 1991). Their populations and range gradually shrank with hunting, overgrazing and agricultural encroachment on natural grasslands. The species disappeared from Egypt and Senegal in the 1950s, and by the 1970s, about only 6,000 animals remained in the wild (Nowak 1991). The *1996 IUCN Red List Animals* listed this species as Critical, Extinct in Algeria, Egypt, Libya, Mauritania, Senegal, and Western Sahara, and probably extinct in Burkina Faso, Chad, Mali, Niger, Sudan and Tunisia. Four years later, the *2000 IUCN Red List Species* listed the Scimitar-horned Oryx as Extinct in the wild. It now survives only in zoos and animal parks.

Another large antelope, the Addax (*Addax nasomaculatus*), once ranged from Western Sahara and Mauritania to Egypt and Sudan. It is now nearly extinct in the wild as a result of heavy hunting combined with loss of its grassland and shrubland habitat to agriculture and competition with livestock. Perfectly adapted to life in the desert, Addax are able to spend their lives without drinking water, deriving moisture from plants on which they feed (Nowak 1991). The *1996 IUCN Red List Animals* listed the Addax as Endangered, Extinct in Algeria, Egypt, Libya, and probably Sudan, and surviving only in Chad, Mali, Mauritania, possibly Niger and as a reintroduced population in Tunisia. Its status declined over the next four years, and in the *2000 IUCN Red List Species*, the Addax is listed as Critical, the most endangered category.

Small gazelles have also declined drastically in the Sahara. The Slender-horned Gazelle or Rhim (*Gazella leptoceros*), native to North Africa, is now extinct in Western Sahara, and endangered throughout its range, according to the *2000 IUCN Red List Species*. The endangered Dama Gazelle (*Gazella dama*), also a heavily hunted species, is extinct in Algeria, Libya, Mauritania, Morocco and Western Sahara; it has been reintroduced into Senegal, and populations are now confined to Chad, Mali, Niger and Sudan (Baillie and Groombridge 1996). Cuvier's Gazelle (*Gazella cuvieri*), another North African species, is extinct in the Western Sahara and survives in endangered populations in Algeria, Morocco and Tunisia, according to the IUCN. Gazelles in the Saudi Peninsula and Near East have suffered similar declines, with several races of gazelle, the Acacia (*Gazella gazella acaciae*) and Muscat (*Gazella gazella muscatensis*), now in the Critical category (Hilton-Taylor 2000). The Saudi Gazelle (*Gazella saudiya*) is now considered Extinct in the wild by the IUCN.

Large herds of Wild Asses (*Equus africanus*) ranged throughout the Sahara in prehistoric times. Over the centuries, they gradually disappeared as a result of hunting and loss of habitat. The species is now Critical, verging on extinction. The Asian Wild Ass (*Equus hemionus*) declined or disappeared in the Near East and Central Asia from the same causes. The Syrian race (*Equus hemionus hemippus*) became extinct in the wild, and other races are now endangered or highly threatened (Hilton-Taylor 2000). Likewise, their close relatives, zebras, have suffered similar fates. Burchell's Zebra (*Equus burchellii burchellii*) is now extinct, and the finely striped Grevy's Zebra (*Equus grevyi*) of East Africa is considered Endangered by the *2000 IUCN Red List Species*.

The southern boundary of the Sahara, the Sahel, is 100 miles closer to the Equator than it was 100 years ago. Somewhat more verdant than the Sahara, the Sahel was a mosaic of grassland and shrubland until recent times. Its decline into desert occurred rapidly. In the late 1970s, an elderly Upper Volta native, Chief Issoufi Alimonzo, recalled: fiThere were once elephants and giraffes and lions here. The father of my father saw them. When his forefathers came to this place 300 years ago, there were so many trees you couldn't see the lake" (Gore 1979). Today, the region is bare of the trees harvested to sell as fuel in the cities of the area, and surrounding countries of the Sahel are experiencing similar devegetation (Gore 1979). Rainfall is now too scarce to permit agricultural crops. Each year, the climate has grown dryer.

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The Serengeti, the great East African savannah, is considered the gem of the African continent. White-bearded Wildebeests (*Connochaetes taurinus*), the keystone animals of the Serengeti, have increased over the past few decades to some 1.5 million, recovering from heavy hunting and habitat modification (Nowak 1999). They are protected by large reserves and national parks in Tanzania and Kenya during the majority of their giant migratory path that takes them in a large circle, returning to the same grasslands each year to have their young. This spectacle was in great danger of disappearing in the mid-20th century when there were plans to carve up the region for private ranches and farms. Conservationist Bernhard Grzimek and others wrote of the international treasure that the Serengeti represented and the importance of preventing its loss in a moving book, *Serengeti Shall Not Die*. Years of work resulted in the protection of much of this grassland. The conditions that prevailed permitting such a disaster to occur were described in the foreword to the book: "One can protest that there is a moral duty to preserve this last of the great natural congregations of wild animals left in existence...But none of this seems to make any difference. The African authorities, both black and white, are decided that the interests of human beings are paramount, and that wherever human beings are in conflict with wild life it is the wild life that must go" (Grzimek and Grzimek 1961). These words proved prophetic for the wildlife of southern Africa described below. Today, it is inconceivable that the Serengeti might be destroyed intentionally, having become a major attraction for scientists and tourists from around the world, but it is being whittled away none the less.

Growing human populations in Kenya and Tanzania have usurped much of the land outside reserves for farmland, and Europeans have long owned large cattle ranches. Animals straying outside the parks are being killed as pests or for bushmeat markets. These savannahs are being fragmented by development up to the very edges of reserves. Wildlife populations have become isolated in protected areas.

Elephants have ancestral migratory routes for food and to obtain minerals from salt licks and caves. The parks often lack sufficient forage for them, and yet when they leave for food, they trample the crops of local farmers or feed in their fields. Many are killed for this, although Kenyan wildlife authorities have tried to prevent such deaths in the late 1990s by protecting farms and relocating elephant families to areas where they are absent as a result of the almost disastrous killing for ivory during the 1970s and 1980s. In spite of this, large animals, including Lions and other predators, are in steep decline in the Serengeti. Just since 1977, an estimated 412,000 large herd animals have disappeared from Kenya's savannahs, some species declining by more than 50 percent (McKinley 1998). National parks encompass only portions of habitats and migratory paths of many species (McKinley 1998). The trend accelerates as the overall population of Kenya is growing at a fast rate, with families having an average of six children. From 5 million in 1946, Kenya's people have increased to more than 28 million today.

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To the east lie the now desertified lands of the Horn of Africa, bordering the Red Sea. The countries of Somalia, Djibouti, Eritrea and Ethiopia occupy this region. Ancient civilizations have risen and fallen here. The Axumites, a Semitic people who conquered the natives of Ethiopia in the 5th century A.D., became a major trading partner with the Greeks and Romans, exporting elephant ivory, rhinoceros horn and Hippopotamus hides. This trade and land abuse may have been responsible for the disappearance of these animals from this area by an early date.

Highland savannahs covered much of the Horn of Africa until the late 19th and early 20th centuries. This region is noted for the high number of highly unusual, endemic species, especially large mammals. Antelope and wild goats,

unlike any in the world, and a beautiful fox-like canid, the Ethiopian or Simien Wolf (*Canis simensis*), are native. During the 1880s and 1890s, the large herds of hartebeest, oryx, antelope, gazelles and zebra that grazed these grasslands were devastated by disease brought by the influx of millions of livestock. Rinderpest, a cattle disease, killed 90 percent of the cattle and then spread to wildlife. In a rampant epidemic in the first years of the 20th century, millions of wild ungulates native to the Eritrean region were decimated (Simon 1995). Even today, the wildlife has not recovered because cattle, sheep and goats have replaced them, turning grasslands into shrub and desert. Many of these unique animals now teeter on the brink of extinction.

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The shrubland and deserts of today's Ethiopia, Somalia and southern Sudan are the product of overpopulation of people and livestock, combined with poor agricultural practices. Famines have killed millions of people in this region during the 20th century, and the destruction of the land has caused massive suffering through hunger and disease. International aid organizations, with the best intentions, supply emergency food and encourage farming and livestock rearing in these damaged areas during each crisis. They often replace livestock after droughts and have failed to educate the people on how to survive without damaging their environment; nor have they provided birth control information. Within a few years of these famines, human populations have risen dramatically, with resultant overgrazing of land by livestock purchased for them by aid organizations, thus repeating the cycle. Funding from these organizations has been crisis-oriented, and famines recur ever more frequently, causing the desert to expand while inflicting great human hardship on these peoples.

Families are encouraged to have large herds of livestock, especially the ecologically devastating goat, and some international aid programs specialize in supplying livestock to people around the world. Within 15 years of deviating famines in the mid-1980s that killed hundreds of thousands of people, drought struck again in 2000, threatening the lives of 16 million people in Ethiopia and neighboring countries (Fisher 2000). A typical family in the area has six to nine children, 200 goats and 60 cattle. In late 1999, after three years without rain, livestock died in huge numbers and families trekked to towns for aid (Fisher 2000). By December, 1999, 7.8 million people faced food shortages, and food shipments were sent by the European Union and aid groups (Fisher 2000).

Neither international aid organizations nor the Ethiopian government have placed a priority on saving the environment and preventing future famines by conservation programs and family planning services. The inhabitants of the region have unknowingly overexploited this dry land, through overgrazing, deforestation and plowing away the topsoil, rendering most of the land area infertile and barren. Ethiopia is a country three times the size of California and, prior to this relatively recent misuse of the land, was one of the most beautiful and wildlife-rich countries in the world. Neighboring Somalia, Eritrea and Djibouti have suffered similar declines in their environment from abuse of the land. There is an urgent need to protect these fragile and beautiful ecosystems and their fauna and flora while helping their people survive in ecologically benign ways. International aid groups and governments should consider projects which help both people and the environment.

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Another arid region, the Kalahari Desert and surrounding grasslands of Botswana, was the scene of a great wildlife catastrophe and massive ecological damage. Early in the 20th century, there may have been almost as many White-bearded Wildebeests in the southern herd as now survive in the Serengeti. The herds numbered at least 272,000 in Botswana (Owens and Owens 1984). Wildebeest from throughout southern Botswana traditionally came together during migration in long, single-file lines, headed toward their ancestral feeding area of lakes, shady

woodlands and grasslands north of the Central Kalahari Game Reserve (Owens and Owens 1984). Over the eons, the wildebeests had adapted to this hot, dry climate and semi-arid grassland. Vast numbers of Beisa Oryx, Giraffe, zebra and other ungulates were a part of this ecosystem.

Europeans, mainly from South Africa, took over enormous tracts of land to raise cattle. Fencing of livestock began in Botswana in the 1950s to control hoof-and-mouth, also known as foot-and-mouth disease. It was thought that this disease was endemic in wild ungulates such as antelope, who spread it to domestic livestock. In fact, there is no proof of this, and it is likely that the disease was introduced to Africa by domestic livestock. The disease may be airborne and, moreover, vaccinations have controlled it in many countries (Owens and Owens 1984). Ranchers, however, had been told by their European sponsors that the beef would be rejected when exported unless fences were built. With subsidies from the World Bank and European countries, they constructed a fence 800 miles long to separate the wildebeests, oryx, gazelles and other wild ungulates from cattle (Owens and Owens 1992). These ranches produced more beef at first than could be easily marketed, creating a huge surplus of beef in Europe and little profit to the ranchers.

The water and grasslands crucial to the survival of the herds were blocked by the fences. The wildebeests walked for days along the fences, hungrier and thirstier every day; they were joined by Giraffe, Gemsbok and zebras whose masses measured 3 miles wide and 5 miles long (Owens and Owens 1984). In 1961 and 1964, 80,000 wildebeests died near the fence, and during these years, an observer estimated that 10 percent of their population died every five days; in 1970, a massive die-off decimated the herds (Owens and Owens 1984). By the early 1990s, the once great southern wildebeest herd had been reduced to fewer than 30,000 animals (Nowak 1999). At least 250,000 wildebeests were killed between 1970 and 1984 (Owens and Owens 1984). The deaths of at least 1.5 million large animals have been called the worst wildlife slaughter of the 20th century (Owens and Owens 1992).

The wildlife die-offs had not been publicized to the world until two American biologists, Mark and Delia Owens, came to the Kalahari in 1974 to study Lions and the threatened Brown Hyenas (*Hyaena brunnea*), native to southern Africa. These hyenas, found only in portions of southern Africa, have been exterminated over much of their range by ranchers; they are continuing to decline and occupy only about half their original distribution after centuries of trapping and poisoning (Kingdon 1997).

The Owenses radio-tracked Brown Hyenas from a small airplane, and in 1979, Mark Owens happened to fly over the tragic spectacle of the dying wildebeest herd. The wildebeests had continued their disastrous migration year after year because no other source of grass and water existed in this parched environment. Mark Owens witnessed hundreds of animals collapsing from hunger, fatigue and thirst. A Giraffe that could have stepped over the fence was so weakened that he got caught in the wire and pitched forward, breaking his leg. His hind legs became ensnared, and he pawed the ground helplessly until he died (Owens and Owens 1984). The main fence north of the Central Kalahari Reserve cut off all but 2 miles of riverine and grassland habitat, and by the time the wildebeests found the end of the fence and saw the lake in the distance, many were so exhausted that they collapsed before reaching it (Owens and Owens 1984). Others, having finally reached Lake Xau, were so weakened that they drowned. In their path were domestic cattle, herded by local people, who had stripped the area of every blade of grass, leaving a concrete-like surface covered with grey powder. Here, even the strongest, prime wildebeests died, their knees buckling and muzzles sinking into the dust. In 1983, 60,000 wildebeests died near Lake Xau (Owens and Owens 1992). Armed men employed by the ranchers patrolled the fences, killing any wild animal that came near. These crews made a business of selling the meat in the country's capital, Gaborone. One of the owners of Safari South had a photograph of a pile of antelope bones "as large as a two-story house" taken near a fence (Owens and Owens 1992). On one occasion, Mark saw the stragglers attempt to reach Lake Xau in the distance, when a truck full of men drove into the herd, killing many under their wheels. Then the men let their dogs attack the wildebeests, hamstringing and disemboweling them, before coming in with knives to finish them off (Owens and Owens 1984). Owens buzzed the men, flying just over their heads to frighten them, and over the next days continued making flights, which apparently succeeded in stopping this slaughter.

The wildebeest die-offs were just the tip of the iceberg. Sixty miles south, up to 10,000 Red Hartebeests (*Alcelaphus buselaphus*) died each year, along with uncounted Gemsbok, Giraffes, Springbok and other desert antelope (Owens and Owens 1992). The decline in the southern herds continued in spite of reports submitted by Owens to the Botswana government on the catastrophic situation. They discovered, in fact, that the government's own wildlife department was well aware of the effects of the fencing and had earlier reports of huge wildlife mortalities in their files (Owens and Owens 1984).

The large ranches of the Kalahari had been drawing water from fossil aquifers which ran dry. Ranchers then moved on, with World Bank loans, to new areas, leaving in their wake "sterile wastelands covered with coils of fence wire and piles of bleached skeletons, the remains of tens of thousands of antelope whose migrations to water had been blocked" (Owens and Owens 1992). The ranchers ran out of wilderness and appealed to the Botswana government to dissolve the Central Kalahari Game Reserve, the second or third largest wildlife preserve in the world, so that they could graze additional cattle. They did not succeed in this goal, but the Owenses (1992) saw livestock 20 miles inside the reserve™s boundaries in 1987.

Unable to stop this slaughter officially or through appeals to major conservation organizations, the Owenses wrote a book, *Cry of the Kalahari*, published in 1984, which outlined the situation and their recommendations to remove fencing, stop human settlements along Lake Xau, and reestablish the wildlife corridor. Excerpts were printed in Life magazine. They noted that the United Kingdom (UK) government had annually donated 14.5 million British pounds to Botswana as a subsidy to the beef industry, and suggested that the money should instead be used to promote ecotourism and wildlife-related industries (Owens and Owens 1984). A filmmaker, Rick Lamba, made a documentary of the slaughter in the early 1980s entitled fiFrightened Wilderness,fl which was shown on the Turner cable networks and to the United States Congress.

Finally, the World Bank funds for these cattle projects ended. They had proved a financial debacle as well as an ecological one, with ranchers never repaying their loans, and the beef sold at 10 percent of what it cost to produce it (Owens and Owens 1992). In the intervening years, the wildebeest herd continued to decline. Between 1979 and 1994, this herd dropped 94 percent, and the hartebeest population fell 83 percent (Boffey 1997). Outside criticism finally resulted in a few improvements. A freeze was put on new settlements along Lake Xau's shores, and the Kalahari Conservation Society was founded, which is monitoring the situation (Owens and Owens 1992). Poaching and harassment of the wildebeest has continued, however, and they are shot, speared and clubbed in their migration, which is likely to end altogether without more dramatic changes in policy. Although World Bank funding has ended, cattle ranches and fences remain, decimating the remaining wildfire.

The Kuke cordon fence that separates the Central Kalahari Game Reserve from areas to the north has been expanded, worsening the plight of this wildlife. Beginning in late 1995, Botswana constructed three new fences in the northwest to prevent a cattle lung disease from spreading from Namibian cattle (Boffey 1997). Two parallel fences of electrified steel wire were built on the northern border with Namibia, extended to meet the border fence, effectively sealing off this area to migrating herds (Boffey 1997). In August 1997, a small plane flying over the area documented antelope attempting to find a way through the fence, and well-worn animal tracks indicating that many others had also tried in vain (Boffey 1997).

The Owenses (1992) describe the changes that took place in this desert: "The Kalahari was teeming with wildlife whose migrations had adapted them to long droughts and sparse grasslands. Large-scale commercial ranchers in the Kalahari killed off hundreds of thousands of wild animals, overgrazed the desert, and depleted the water from fossilized aquifers. They left a wasteland that was good for neither wild nor domestic stock." Along with the wildebeests and other ungulates went the once large populations of Lions, Leopard, and Brown Hyenas.

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In neighboring Namibia, Europeans also exterminate native ungulates and predators in vast areas in order to make room for cattle and agriculture. The wildlife of Namibia has declined almost as rapidly as that of the other two countries. A few national parks, such as the Namib, have prevented total extinction for some species. One of the largest protected areas, however, has been reduced to one-fourth its original size as a result of pressure from livestock owners. The Etosha Game Reserve of southern Namibia covered 38,427 square miles, equaling the Okavango Delta and Tanzania's Serengeti Plains, a region of great wildlife diversity and abundance (Simon 1995). Although designated a national park, it covers only 8,598 square miles, the rest having been given over to livestock and agricultural interests (Simon 1995). This park is a lifeline for the remaining wildlife, with waterholes even during the dry season that attract herds of Plains Zebra, wildebeest, hartebeest, Gemsbok, Kudu, Springbok, Giraffe and others (Simon 1995). In its dry woodlands, elephants graze. During the 1990s, anthrax swept Ethosha, introduced by livestock, and 30 Cheetahs died, nearly the entire population in the reserve, along with elephants, zebra and other ungulates.

The Mountain Zebra (*Equus zebra*), native to Angola and Namibia, was once abundant in the high country of the eastern Namib and deep into the desert as far west as the coast (Simon 1995). Today, the species is listed as Endangered by the *2000 IUCN Red List Species*. Superbly adapted to the dry environment, this zebra scrapes holes in dry river beds, allowing water to seep in. In this way, it creates waterholes for many other animals (Simon 1995). The Hartmann's Mountain Zebra (*Equus zebra hartmannae*), a very large race of the Mountain Zebra, numbered an estimated 50,000 to 75,000 in the 1950s (Nowak 1999). Competition with domestic livestock and persecution from farmers settling the region reduced them to only about 8,000 (Nowak 1999). Listed as Threatened by the U.S. Endangered Species Act and on Appendix II of CITES, Hartmann's Mountain Zebras are still being illegally killed, with about 500 to 1,000 skins a year taken by poachers (Nowak 1991). The Cape Mountain Zebra (*Equus zebra zebra*), the other race of Mountain Zebra, was originally common in the grassy highlands of Cape Province, South Africa. European settlers killed these zebra indiscriminately, virtually wiping them out, along with many other species of ungulates. As early as 1742, these zebra were considered threatened and were given official protection (Kingdon 1997). This hunting ban was ignored, however, reducing them to 11 animals, protected on the farm of Henry Lombard, who prevented their extinction (Kingdon 1997). A 1937 census found only 45 Cape Mountain Zebra, although a few more persisted in remote mountain areas (Nowak 1991). The Mountain Zebra National Park was established to preserve them, and their numbers rose to 474 in the 1980s, half of which lived in the park (Nowak 1991). They increased to about 700 in six reserves in the mid-1990s, all descended from seven females (Kingdon 1997). This race is listed as Endangered by U.S. Endangered Species Act, the IUCN, and is on Appendix I of CITES.

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In South Africa, herds of Black Wildebeest (*Connochaetes gnou*) have also been nearly exterminated by ranchers and farmers. Fewer than 10,000 survive in government and private preserves (Nowak 1999).

South Africa's heath and grasslands harbor hundreds of species of rare plants, and European settlement pushed many of these close to extinction. Vast areas have been plowed for agriculture, and entire families of endemic plants have been threatened. Proteas are among the most endangered of these endemic plants. These plants have beautiful flowers, and one highly endangered species, *Protea odorata*, has a white, lily-like bloom contrasting with red-rimmed, narrow leaves. This plant declined from a population of more than 1,000 plants in five populations in the early 1980s,

to a few plants by the mid-1990s (Hilton-Taylor and Paterson-Jones 1996). *Protea odorata* had a limited range of only 30 square kilometers on the Western Cape lowlands, growing in water-logged, gravelly, clay soil (Hilton-Taylor and Paterson-Jones 1996).

The Cape's heathland is highly threatened by farming, and even the untilled portions are being grazed by sheep and cattle. This plant regenerates from seed after fires that must be at intervals of from 7 to 12 years to allow the plants to grow, flower and produce seed (Hilton-Taylor and Paterson-Jones 1996). The site of the last three wild plants of *Protea odorata* was a privately owned piece of land near Joostenberg; the owner of the land, in full knowledge of the illegality of his action, cleared the site and planted oats (Hilton-Taylor and Paterson-Jones 1996). He has been charged, but South African law allows only a minor fine to be levied. Fortunately, this plant has been cultivated at Kirstenbosch National Botanical Garden, and seedlings will be reintroduced in Riverlands Nature Reserve where it once occurred (Hilton-Taylor and Paterson-Jones 1996).

European settlement has pushed many of these plants and the native wildlife close to extinction. The statuesque Bontebok antelope (*Damaliscus dorcas dorcas*) was once abundant in the region, but settlers nearly caused their xtinction. Today, a national park and some private land protect a population total of about 2,000 animals (Cowling and Pierce 1999).*

Drylands of the World: AFRICA: Footnote

*Proteas are featured in two beautiful film, fiFlower from the Flamesfl (BBC), showing their pollination by iridescent sunbirds and ecology in coastal South Africa, and fiNamaqualand. Diary of a Desert Gardenfl (Nature, PBS), which also shows the superb wildflower displays in this desert of southwest and western South Africa and its wildlife. These ecosystems are described in detail and illustrated with color photographs in *Wild South Afria* (MIT Press, 1998), a book in a series that focus on the biodiversity, reserves and conservation of various parts of the world.

Only about 51 percent of the original 74,000 square kilometers of habitat remains in its natural state, and only half of this is in a pristine state. Moreover, certain portions of the ecosystem exist only in isolated fragments among pesticide-treated farmland (Cowling and Pierce 1999). Farmers have even planted tea crops in mountain habitats, displacing native plants (Cowling and Pierce 1999). Sheep and cattle grazing is a major problem as well. Remnant habitat patches are also being invaded by the Australian tree, *Acacia saligna*, which is replacing native vegetation in many areas. Other exotic plants from the Mediterranean and a pine from California have also taken over as much as 36 percent of the habitat, depleting scarce water supplies (Cowling and Pierce 1999). All these factors combine to threaten 1,406 plant species listed by the *IUCN Red List*, of which nearly 300 are close to extinction and 29 are already extinct in the wild; added to this, six species of butterflies, seven fish, five amphibians, five reptiles, 12 birds and 21 mammals of the region are threatened with extinction (Cowling and Pierce 1999).

A change in attitude toward nature in South Africa has resulted in the establishment of 244 nature reserves and parks covering 14,060 sq. km, but 95 percent of this land is in mountain areas which are among the least threatened (Cowling and Pierce 1999). Less than 5 percent of lowlands is conserved, and the government has insufficient funds to buy critical areas (Cowling and Pierce 1999). However, in recent developments, alien plants are being removed to restore the water and habitat, with 48,043 hectares (118,714 acres) already cleared of exotics. New protected areas have been declared, including the Cape Peninsula National Park, the Cape Agulhas National Park and the West Coast Biosphere Reserve, and $6 million has been donated for plant conservation (Cowling and Pierce 1999). This rugged region may also become a tourist attraction, especially the habitat closest to Cape Town, with its spectacular ocean views and growing populations of native animals such as the Jackass Penguin colonies.

Africa has the greatest diversity of hoofed mammals in the world, the majority of which inhabit grasslands, shrub,

shrubland and desert. This superb variety is under threat throughout the continent, as habitat disappears, even in national parks. The Table, fiThreatened Mammals of Africa's Savannahs and Deserts,fl lists the startling count from the *2000 IUCN Red List Species*, encompassing all but a very few grazing and predatory mammals of these habitats. The 84 mammals, 41 of which are in higher categories of threat, have evolved over thousands of years in intricate adaptations to various food sources, habitats and climates. Within each habitat many species coexist, each exploiting a different habitat niche, such as tall plants or shrubs, grasses or woody vegetation. Predator and prey have evolved together, each benefiting the other. Grazing animals vary from the tiny Silver Dikdik, only a few feet tall, to the Giant Eland, rhinoceroses, and the largest, the African Elephant, weighing several tons. Some can scramble up vertical cliffs, and others leap in 30-foot arches over the savannah. Cheetahs, Leopards, hyenas and foxes are among the declining predators. One of the biggest surprises of the *2000 IUCN Red List Species* was that even species that are relatively common, such as the White-bearded Wildebeest, Giraffe, Lion, many gazelles, zebras and antelope, have become Conservation Dependent, surviving only through conservation programs or in national parks. Should all these animals fade to near-extinction or totally disappear, they will represent an enormous loss similar to the mass extinctions of large mammals of the Pleistocene. Imaginative solutions are needed to conserve these beautiful animals in the face of expanding agriculture and livestock grazing, which daily usurp more and more of their territory. The value of ecotourism to economies, especially when spread throughout neighboring communities, is one solution that is being adopted in a growing number of places. The teaching of better farming methods that consume less land, and environmental education, are other solutions. As in many parts of the world, the wildlife that is taken for granted by local peoples in Africa as uninteresting and not worth saving, is considered a great biological treasure by biologists and naturalists around the world.

Threatened Ungulates & Predators of African Drylands
Extinct in the Wild
Critical
Endangered
Vulnerable
Near-Threatened
Data Deficient
Conservation Dependent
AUSTRALIA

Threatened Ungulates & Predators of African Drylands: Extinct in the Wild
Known only to survive in captivity or as a population outside its original range after exhaustive surveys in the wild have failed to record any individuals.

-
Scimitar-horned Oryx *(Oryx dammah*)

Threatened Ungulates & Predators of African Drylands: Critical
Species or subspecies face an extremely high risk of extinction in the wild in the immediate future

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Addax (*Addax nasomaculatus*)
African Ass (*Equus africanus*)
Black Rhinoceros (*Diceros bicornis*)
Ethiopian Wolf (*Canis simensis*)
Giant Sable Antelope (*Hippotragus niger variani*)
Hunter's Hartebeest or Hirola (*Damaliscus hunteri*)
North African Leopard (*Panthera pardus panthera*)
Northern White Rhinoceros (*Cerototherium simum cottoni*)
Walia Ibex (*Capra walie*)

Threatened Ungulates & Predators of African Drylands: Endangered
Species or subspecies face a very high risk of extinction in the wild in the near future.

African Elephant (*Loxodonta africana*)
African Wild Dog (*Lycaon pictus*)
Cuvier's Gazelle (*Gazella cuvieri*)
Dama Gazelle (*Gazella dama*)
Grevy's Zebra (Equus grevyi)
Mountain Nyala (*Tragelaphus buxtoni*)
Mountain Zebra (*Equus zebra*)
Northwestern African Cheetah (*Acinonyx jubatus hecki*)
Nubian Ibex (*Capra nubiana*)
Slender-horned Gazelle (*Gazella leptoceros*)
Swayne's Hartebeest (*Alcelaphus buselaphus swaynei*)
Tora Hartebeest (*Alcelaphus buselaphus tora*)
Western Giant Eland (*Taurotragus derbianus derbianus*)
Western Klipspringer (*Oreotragus oreotragus porteousi*)
Western Mountain Reedbuck (*Redunca fulvorufula adamariae*)

Threatened Ungulates & Predators of African Drylands: Vulnerable
Although not Critical or Endangered, facing a high risk of extinction in the medium-term future.

Barbary Sheep (*Ammotragus lervia*)
Beira Antelope (*Dorcatragus megalotis*)
Black-faced Impala (*Aepyceros melampus petersi*)
Bontebok (*Damaliscus pygargus pygargus*)
Cheetah (*Acinonyx jubatus*)
Clarke's Gazelle (*Ammodorcas clarkei*)
Dorcas Gazelle (*Gazella dorcas*)
Gerenuk (*Litocranius walleri*)
Haggard's Oribi (*Ourebia ourebi haggardi*)
Lion (*Panthera leo*)
Puku (*Kobus vardonii*)
Red-fronted Gazelle (*Gazella rufifrons*)

Silver Dikdik (*Madoqua piacentinii*)
Soemmerring's Gazelle (*Gazella soemmerringii*)
Somali Warthog (*Phacochoerus aethiopicus delamerei*)
Speke's Gazelle (*Gazella spekei*)

Threatened Ungulates & Predators of African Drylands: Near-Threatened
Species or subspecies which is close to qualifying for Vulnerable.

Brown Hyena (*Hyaena brunnea*)

Chanler's Mountain Reedbuck (*Redunca fulvorufula chanleri*)

Giant Eland (*Taurotragus derbianus*)

Mongalla Gazelle (*Gazella thomsonii albonotata*)

Nile Lechwe (*Kobus megaceros*)

Royal Antelope (*Neotragus pygmaeus*)

Sitatunga (*Tragelaphus spekeii*)

White-eared Kob (*Kobus kob leucotis*)

Threatened Ungulates & Predators of African Drylands: Data Deficient
Inadequate information exists to make a direct, or indirect, assessment of its risk of extinction because appropriate data on abundance and/or distribution is lacking. More information is needed, and there is a possibility that future research will show that Threatened classification is appropriate.

Barbary Hyena (*Hyaena hyaena barbara*)
Chapman's Zebra (*Equus burchellii chapmani*)
Crawshay's Zebra (*Equus burchellii crawshayi*)
Fennec Fox (*Fennecus zerda*)
Pale Fox (*Vulpes pallida*)
Rueppell's Fox (*Vulpes rueppelli*)
Upper Zambezi Zebra (*Equus burchellii zambeziensis*)

Threatened Ungulates & Predators of African Drylands: Conservation Dependent
Species which does not currently qualify as Critical, Endangered or Vulnerable, but must be the focus of a continuing conservation program, the cessation of which would result in its qualifying for one of the Threatened categories above.

African Buffalo (*Syncerus caffer*)
Black Wildebeest (*Connochaetes gnou*)
Blesbok (*Damaliscus pygargus*)
Bohor Reedbuck (*Redunca redunca*)
Cape Grysbok (*Raphicerus melanotis*)
Common Eland (*Taurotragus oryx*)
Common Hartebeest (*Alcelaphus buselaphus*)
Gemsbok (*Oryx gazella*)
Giraffe (*Giraffa camelopardalis*)
Grant's Gazelle (*Gazella granti*)
Greater Kudu (*Tragelaphus strepsiceros*)
Grey Rhebok (*Pelea capreolus*)
Klipspringer (*Oreotragus oreotragus*)
Kob (*Kobus kob*)
Lechwe (*Kobus leche*)
Lesser Kudu (*Tragelaphus imerbis*)
Lichtenstein's Hartebeest (*Alcelaphus lichtensteinii*)
Mountain Reedbuck (*Redunca fulvorofula*)
Nyala (*Tragelaphus angasii*)
Oribi (*Ourebia ourebi*)
Sable Antelope (*Hippotragus niger*)
Sharpe's Grysbok (*Raphicerus sharpei*)
Spotted Hyena (*Crocuta crocuta*)
Springbok (*Antidorcas marsupialis*)
Thomson's Gazelle (*Gazella thomsonii*)

Tsessebe (*Damaliscus lunatus*)
White Rhinoceros (*Cerototherium simum*)
White-bearded Wildebeest (*Connochaetes taurinus*)

Source: Species list and category definitions from *2000 IUCN Red List Species*. Compiled by Craig Hilton-Taylor. IUCN, Gland, Switzerland and Cambridge, UK.

Threatened Ungulates & Predators of African Drylands: AUSTRALIA

Australia has been ecologically devastated by a combination of factors over the past 200 years. A continent dominated by drylands, its great center is a vast desert. Dry shrub forest originally covered much of the rest of the country. Only in the east and the northeastern tip of Queensland did tropical or subtropical forests prevail. Its climate has become dryer over the past few centuries as a result of overgrazing by livestock and forest clearance. Deserts have grown in area, claiming an ever greater percentage of the continent. In many parts of the country, shrublands and grasslands have been replaced by desert, causing extinctions and endangering native animals. Settled by former British prisoners and immigrants, sheep and cattle ranching became the center of the Australian economy in the 19th century. Within 200 years, massive ecological destruction has resulted from their activities. Livestock were released into the delicate environment, overgrazing grasslands and other habitats. Australia is second only to China in the number of sheep grazed, some 123 million, producing wool worth $5 billion, but leaving the land devegetated (O'Neill 1997). Gordon Grigg, professor of zoology at the University of Queensland in Brisbane, estimates that 700,000 square miles of arid zone habitat, or over half of Australia, are so degraded from sheep grazing that they may become permanent desert (Grigg 2000).

Forests were cleared for grazing land, agriculture, construction of railway ties, charcoal making and fuel for factories. More than 70 percent of Australia™s native forests have been destroyed (Lines 1991). Two-thirds of all arable land has been degraded by agriculture and livestock activities; of the continent's 7,750 million square kilometers, only the remotest, unused desert areas of Western Australia have no degraded land (Lines 1991). The story of the destruction of Australia's native flora and fauna has been carefully chronicled in the book, *Taming the Great South Land. A History of the Conquest of Nature in Australia*, by William J. Lines (1991).

Added to the livestock and land clearing threats were a flood of non-indigenous animals released by Acclimatisation Societies to "increase Australian usefulness" (Lines 1991). Rabbits, foxes, cats, mice and rats, European birds, exotic plants and all manner of goats, camels, donkeys and horses multiplied without natural enemies. Mice, rats and rabbits reached plague proportions, consuming vegetation and crops. Cats and foxes preyed on native birds and mammals who had few defenses against them. Eurasian rats ate birds' eggs and even preyed on tiny mammals and their young.

The European Rabbit proved the most destructive introduction, proliferating into the billions. Had native mammal predators, such as hawks, eagles, Dingoes and marsupial carnivores, been protected, they might have kept the rabbits and other exotics in check. But they were driven out by hunting and habitat destruction (Kennedy 1990, Lines 1991). By 1880, rabbits had overrun vast areas of shrub, devouring leaves, branches and trunks, killing native trees and grasses (Lines 1991). In the first 8 months of 1887, 10 million rabbits were destroyed in New South Wales, but this had little effect on their numbers (Lines 1991). Fences were erected over stretches as long as 500 kilometers in Queensland, where thousands of rabbits, having stripped the land bare, piled up against the wire, starving to death in sight of the green on the other side (Lines 1991).

Australians moved into new areas, bringing the rabbits as a meat source, and by the early 20th century, rabbits had denuded most of Western Australia, including an extremely important biodiversity "hotspot" in the far southwest.

Diseases and poisons, traps and hunting, all failed to eliminate rabbits, whose populations continue to rise and fall in plague proportions. In the late 20th century, experimental distribution of a poison derived from a plant to which native animals were immune was broadcast over millions of acres. This poison is known as Compound 1080 in the United States, where it was widely used against Coyotes and other predators before being restricted. It kills domestic dogs and cats as well, who die a very slow death. It also has secondary effects, i.e., animals that eat meat from animals killed by 1080, can be poisoned. It stays in the environment for long periods, killing hawks, owls and many other animals. This has brought about the protests of many humane organizations in Australia, but use of the poison continues.

Native mammals began to vanish during the 19th century, with the rate of extinction rising during the early 20th century (see Appendix). Twenty-three native Australian mammals have become extinct in the past 200 years, the majority of which are dryland species (Kennedy 1990). Australia now has the dubious honor of having experienced more mammal extinctions than any other continent (Kennedy 1990). In fact, 33 percent of arid zone mammals are extinct, and 90 percent of all medium-sized desert mammals are either extinct or threatened with extinction (Kennedy 1990). Seventy-one species of vascular plants have also become extinct (Walter and Gillett 1998). Most of the latter are dryland species. In all, 35 Australian animals have become extinct, 483 are highly threatened and 248 are in lesser categories of threat (Baillie and Groombridge 1996). Of 15,638 native vascular plants, 2,245 species are threatened, a rate of 14.4 percent (Walter and Gillett 1998).

Australia's land mass is approximately the same size as the lower 48 U.S. states, but it has proportionately far more threatened species. Endemic marsupials, such as many types of wallabies and native rodents other than large kangaroos, have either disappeared altogether from territories that once covered thousands of square miles or cling to existence in tiny reserves on small islands off the coasts where non-native animals are absent. With such limited ranges, many will probably die out. In fact, the majority of once wide-ranging species have been squeezed into small areas, a fraction of their original ranges. A wave of extinctions among species that are now endangered will probably occur within the next 50 years, according to some scientists. The majority of Australia's threatened species exist outside national parks and nature reserves, which contributes to a pessimistic view of their long-term survival.

The wildlife that inhabited Australia prior to European settlement included the most diverse marsupial fauna in the world. The majority inhabited dryland regions and have strange-sounding names that reflect their total uniqueness, resembling no other mammals on Earth. Quolls, wallabies, wombats, koalas, pademelons, potoroos, and bettongs are among these fascinating creatures. Almost all are now either extinct or in various states of endangerment. Each evolved over hundreds of thousands or millions of years to occupy an individual ecological niche, adapting to a variety of arid environments.

One of the rarest and strangest is the Bilby, or Rabbit-eared Bandicoot (*Macrotis lagotis*). A small burrowing animal, it has large ears, a long, pointed snout, and soft blue-grey fur washed with pinkish-brown, ending in a black-and-white crested tail, carried like a stiff banner while it canters along (Strahan 1995). The Bilby male can reach over 21 inches, while the female is only 11 inches long (Nowak 1999). Their burrow, which they can dig very rapidly with their clawed front feet, is spiral and up to 6 feet deep and 10 feet long, affording them protection from the searing heat of their desert habitat (Berra 1998). Sheltering during the day in their burrow, they do not lie down to sleep, but squat on their hind legs and tuck their muzzle between their forelegs with their long ears folded forward over the eyes (Nowak 1999). At night, they emerge to feed on insects, small vertebrates, seeds and fungi. Able to survive in the driest and hottest of Australian deserts, Bilbies once occupied all of central, western and southern Australia (Kennedy 1990). Their preferred habitat of hummock grasslands and acacia shrublands with spinifex and tussock grass has been degraded by cattle and rabbits (Kennedy 1990), and they have been trapped and preyed on by cats and foxes (Strahan 1998, Nowak 1999). Close to extinction, Bilbies survive only in a few isolated colonies in Western Australia, the Northern Territory and southwestern Queensland (Nowak 1999). The species is listed as endangered by the U.S. Endangered Species Act and Vulnerable by IUCN. Captive-breeding programs have been successful, and reintroduction programs are attempting to bring the species back to portions of its former range (Kennedy 1990).

A similar species, the Lesser Bilby (*Macrotis leucura*), inhabited the deserts of South Australia and Northern Territory until the early 20th century when it became extinct. Last seen in 1931, this delicate marsupial was eliminated by the same factors that have endangered the Bilby (Nowak 1999).

The Eastern Barred Bandicoot (*Perameles gunnii*), a close relative of Bilbies, inhabits heath, grassland and dunes in southern Victoria and Tasmania. With smaller ears than the Bilby, it also has soft, grey fur, but its back is barred with horizontal stripes of white. It has nearly disappeared from mainland Australia in the southeast and remains only in Hamilton in southwest Victoria, surviving in suburban gardens, nearby grasslands and a car dump site; three new captive colonies have been established elsewhere in Victoria (Kennedy 1990, Strahan 1998). Foxes and other introduced predators, as well as habitat destruction, are blamed for its perilous status. In Tasmania, where foxes are absent, it is more widely distributed, but it is declining here, too (Nowak 1999, Strahan 1998). Total population was estimated at only 633 in 1985, declining to 236 in 1988 and less than 100 in 1992 (Nowak 1999). Its counterpart, the Western Barred Bandicoot (*Perameles bougainville*), once ranged from central New South Wales west to the Indian Ocean. Today, this species' entire habitat consists of two small, predator-free islands--Bernier and Dorre Islands--off the central coast of Western Australia (Kennedy 1990). Native to a semi-arid habitat of shrub and open plains, its decline to near-extinction went unchronicled but is assumed to have been caused by habitat destruction, competition for food with rabbits and predation by foxes, cats and domestic dogs (Nowak 1999).

Two other members of the genus are now extinct: the Desert Bandicoot, *Perameles eremiana* of southern Northern Territory, northern South Australia and southeastern Western Australia, was last seen in 1931; a close relative, *Perameles fasciata*, disappeared about 1867. Yet another species, the Pig-footed Bandicoot (*Chaeropus ecaudatus*), the sole member of its genus but very closely related to the species above, became extinct in 1907 (see Extinct Species List in Appendix). Such devastation of entire groups of endemic species, mirrored in the fate of many other native Australian marsupials, has no parallel in recent history.

Another extraordinary family of marsupials is in steep decline. Wombats are heavy, up to 5 feet long, with thick bodies, very short legs, and tiny eyes; they weigh up to 77 pounds (Nowak 1991). In spite of their ungainly appearance, they are able to achieve speeds as high as 40 miles per hour for short distances (Nowak 1999). Endemic to Australia, there are three species in the Vombatidae family. Prior to European settlement, they were found throughout the continent in open grasslands and savannah with scattered trees and woodlands. Quite timid, they spend most of their time during the day, especially in hot climates, in extensive burrows which they excavate with their long, sharp claws, venturing out at night to feed on grasses, roots, bark and fungi (Nowak 1999). Their complex of tunnels leads to underground chambers so intricate that they are called cities. Sometimes several wombats occupy them, encountering one another only during breeding season, yet there is only one entrance.

All wombats have suffered declines from persecution by farmers who fear cattle will become injured by falling into the burrows, and many have been accidentally poisoned and gassed in rabbit-control programs because the latter animals seek shelter in wombat burrows (Nowak 1999). Ranchers routinely fill wombat holes (O'Neill 1997). Destruction of grasslands from overgrazing and agriculture has also eliminated populations (Kennedy 1990).

In spite of their somewhat imposing appearance, wombats are extremely gentle and playful in captivity (Nowak 1999). During a rash of forest fires in 1993 in New South Wales, many Common Wombats (*Vombatus ursinus*) became burned when they left their burrows to forage. Their paws were scorched by hot, smoldering soils, and they were unable to move; local people rescued many of the burned and frightened animals and nursed them back to health in their homes. Even though traumatized and shy of people, wild wombats could be carried about like huge puppies, submitting docilely to veterinary treatments.

Two of the three wombat species are listed in *Australia's Endangered Species* (Kennedy 1990). The most endangered is the Northern Hairy-nosed Wombat (*Lasiorhinus krefftii*), which is on the brink of extinction. Gone from New South Wales and southeastern Queensland, this wombat is confined to a tiny area of 15.5 square kilometers

in Epping Forest National Park, east-central Queensland (Kennedy 1990, Nowak 1999). Once native to open savannah and eucalypt woodland in New South Wales and Queensland, this species' total population has been reduced to only about 70 individuals (Nowak 1999). This wombat has been classified as Critical by the *1996 IUCN Red List* (Baillie and Groombridge 1996). These wombats are being studied by biologist Andrew Woolnough.

The Southern Hairy-nosed Wombat (*Lasiorhinus latifrons*) has declined in numbers and distribution from its original wide range from southeastern Western Australia to New South Wales, the entire southern half of the continent. Still fairly common in some areas, this species occupies a more arid habitat of near-desert conditions and has declined because of land clearance, overgrazing, and persecution by farmers, many of whom shoot this animal on sight (Kennedy 1990) based on mistaken beliefs that wombats damage fences and compete with livestock for grazing (Nowak 1999).

Australian grasslands have been severely degraded by livestock grazing. Once covered in perennial grasses that formed erosion-resistant mats, what vegetation remains is dominated by annual grasses (Fitzherbert and Baker-Gabb 1988). During the 19th century, untold millions of sheep and cattle grazed Australia's grasslands and deserts, and the damage they did to the soil and vegetation may be irreparable. Native saltbush has been eliminated on some steppe lands, and the diversity of native plants has been greatly reduced. Only since the 1940s have large private ranch holdings been broken up, and Australian ranchers have developed a greater awareness of the negative effects of livestock on the land (Fitzherbert and Baker-Gabb 1988).

Sheep ranchers have nearly eliminated many native animals by constructing a 3,307-mile fence across southeastern Australia to prevent Dingoes from entering southern areas where sheep are raised (O'Neill 1997). This fence prevents natural migrations of kangaroos and Emus, who can be seen running along the fence for miles, seeking an opening to cross (O'Neill 1997). Many die in collisions with the fence or from dehydration after trying for days to enter an area with grazing and water. The fence has not succeeded in keeping Dingoes, which number about 1 million in the country, out of sheep territory (O'Neill 1997). Dingoes are savagely persecuted in sheep country, poisoned, trapped in steel jaw leghold traps, shot and hung from fence posts (O'Neill 1997).

Australia's birds have also suffered from desertification and other activities of European immigrants. Ten Australian parrot species are listed in various degrees of threat by BirdLife International, and one is now considered extinct (Collar *et al*. 1994). The Paradise Parrot (*Psephotus pulcherrimus*) was last seen in 1927 (Greenway 1967). This beautiful parrot of central eastern Australia's grasslands was probably never very common; it lived in grassy woodlands and river valleys, the very habitat that was usurped by cattle ranchers (Fitzherbert and Baker-Gabb 1988). These were technicolor birds. The male was a dazzling combination of turquoise and emerald green on his breast, cheek and flank feathers, set off by black on wings, head and tail; he had large splashes of red on his wings, belly and forehead and his dark eyes were encircled by yellow. The female was a slightly paler version of the male. Their habitat degraded in the 19th century with heavy livestock grazing, and by 1915, these birds had become very rare (Forshaw 1989). Great beauty and relatively small size--11 inches in length including the tail-- made it attractive as a cage bird. Paradise Parrots were tame, feeding in pairs on the ground, and so were easily trapped for the cage bird trade, which pushed the already rare birds to extinction.

The rarest grassland parrot is the 9-inch Night Parrot (*Geopsittacus occidentalis*), whose greenish-yellow plumage mottled with dark brown, black and yellow allows it to blend into its spinifex grassland habitat (Forshaw 1989). This extremely mysterious species, seen in widely scattered localities of the arid interior of Australia, disappeared about 1912 and was thought extinct; then the species was sighted in 1979 in South Australia when several Night Parrots were flushed from underneath bushes (Forshaw 1989). These parrots spend most of their time on the ground and are thought to be nomadic. More recently, they have been seen in Western Australia, and a dead Night Parrot was found in 1990 (Collar *et al*. 1994). Grazing by livestock and the threat from introduced predators, such as foxes and cats, have contributed to their decline (Collar *et al*. 1994). They are so rare that no studies have been carried out on their diet or life history, but it is presumed to be nocturnal.

The greatest threat to Australia's grassland plants, preventing many of them from germinating, is heavy grazing by sheep, cattle, rabbits, goats, horses and donkeys (Kennedy 1990). One outspoken conservationist and landowner, John Wamsley, has established a sanctuary for native wildlife and plants. He excludes all livestock, foxes, rabbits, cats and other exotics with strong fences. He claims that the Australian government lacks resolve in protecting endangered species and their habitats, and with more fences and sanctuaries similar to his own, he believes that native wildlife could reoccupy habitats and recover their numbers. He has enlarged his preserve to over 100,000 acres. This may be the only area in mainland Australia where native mammals are increasing.

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Endangered Species Handbook

Aquatic Ecosystems:

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Introduction

The marshes, lakes and seas of the world are host to a great diversity of life. In Asian wetlands, brightly colored storks step through reeds while scanning the shallow water for tiny fish. Marsh deer leap gracefully on their wide hooves through mud and spongy vegetation in Brazil's Pantanal. Great flocks of sandhill cranes darken the skies over North American rivers and bogs, emitting their haunting, hoarse cries as they circle to land. Otters, native to all continents except Australia, cavort on river banks, squealing to one another as they leap into the water. Eurasian and American beavers dam rivers, creating ponds where dragonflies, fish, frogs and aquatic mammals thrive. Papyrus swamps line many great rivers in Africa, home to strange shoebill storks, lechwe antelope, crocodiles and hippopotamuses. These aquatic habitats are a lifeline to hundreds more species of birds and mammals who come to drink and bathe. Freshwater ecosystems occupy a tiny fraction of the Earth's surface, unlike saltwater habitats, which cover three-fourths of the planet. Along tropical coasts, mangroves shelter tiny shrimp, crabs and fish. Manatees glide slowly in these quiet waters. A dazzling array of coral grows in fantastic shapes in tropical waters, inhabited by fish, anemones and starfish in every imaginable color, pattern and shape. Throughout the world's seas, whales, dolphins and seals leap above the waves and communicate with one another in complex musical sounds. Bizarre, deep-sea creatures inhabit sulphur-spewing hot vents or lightless sea floors. Wondrous habitats and their wildlife have undergone massive degradation caused by human activity. Many have disappeared altogether over the past few centuries and an even greater number are being destroyed or are losing many native species.

Benefits of Aquatic Ecosystems

Water, the basis of life on Earth, is the most precious of all natural resources. Freshwater and coastal wetlands cover only about 6 percent of the Earth's surface (Lean and Hinrichsen 1992), but produce three-fourths of the world's fish. Coastal marshes and mangroves play a major role in supporting diversity in the oceans by serving as spawning grounds and nurseries for two-thirds of the saltwater fish and shellfish caught for commercial purposes worldwide (Lean and Hinrichsen 1992). Wetlands perform a major role in preventing floods by retaining rainwater for slow release during the year and absorbing large amounts of rainfall, runoff and snowmelt. Wetlands also filter out contaminants. Some communities in the United States now construct wetlands for the purpose of filtering treated sewage water.

In a new approach to nature conservation, "Earth's Worth" scientists have begun calculating the dollar values of services performed by nature. Traditional economics value natural ecosystems only by practical use to human economies in short-term projects, such as real estate development or resource extraction. For example, how much a wetland is worth is a reflection of tax assessments, which are based on development possibilities and resale values. A boggy woodland might be appraised at a fairly low rate because it is difficult to develop for housing or other buildings. For this reason, such habitats are often bought at low prices and destroyed by development. By contrast, when one considers the ecological services rendered by that aquatic ecosystem, its values are far greater. It absorbs rainwater, thus preventing floods, provides a nursery area for aquatic wildlife and preserves woodland, which produces oxygen. The clean water supplied worldwide by natural filtration by marshes and mollusks that filter water was estimated by a group of ecologists to be valued at a minimum of $1.7 trillion (Stevens 1997). Estuaries and coastal wetlands are nurseries for multi-billion-dollar fisheries and shell fisheries, while they are also valuable in preventing floods. Yet such wetlands, which are often seen as ideal locations for ports and cities, are routinely filled for development. Scientists at the University of California at Berkeley calculated that the remaining wetlands in that state, 91 percent of which have been destroyed, are worth $10 billion annually in ecosystem services (Williams

1996). These ecosystems are usually considered virtually worthless by developers and industry.

The beautiful salt marshes of Georgia were under threat a few decades ago when it was discovered that large deposits of phosphate, which commercial interests wanted to mine for use as fertilizer, lay beneath them. Dr. Eugene Odum, who founded the science of ecology (Odum 1971) and taught at the University of Georgia, was able to prove to the state legislature that the long-term gain from these marshes as nurseries for the valuable shrimp and fish industries far exceeded the short-term profits that would accrue from permanently destroying them by mining. They received legal protection, an important precedent that recognized the economic value of wetlands. Since then, coastal marshes and other wetlands have attracted millions of tourists who come to see the wildlife and beautiful vistas that these habitats provide. Such visitors provide more income to the localities involved than extraction of minerals or development, since ecotourism is permanent.

The reason coastal wetlands and mangroves provide such important nurseries lies in the supply of nutrients they receive from ocean tides and freshwater runoff and rivers. Delta wetlands are especially rich in these nutrients brought by inland rivers and the tides. These floods bring nitrates, nitrites and minerals that nourish the vegetation of the wetlands. This rich habitat was eloquently described in Rachel Carson's *The Edge of the Sea* (1955). Among the grasses and reeds, microscopic life and invertebrates feed a great diversity of fish, shrimp, crabs, mammals, reptiles, amphibians and birds. Bivalves filter the water of aquatic ecosystems, keeping it clear and free of silt and pollutants. Freshwater marshes, lakes and ponds are breeding areas for crustaceans, mollusks and many vertebrates. Millions of waterfowl breed in the seasonal sloughs and potholes of North America prairies. Temporary wetlands, such as the vernal pools or wet season ponds, provide important habitat and breeding areas for frogs, toads, turtles, birds and a rich variety of invertebrates and plants.

Ancient peatlands and sphagnum bogs can be found on every continent except Antarctica. These wetlands absorb vast amounts of rainwater and store it year-round. Their soils tend to be poor in nutrients, but a wide variety of plant life has adapted to these habitats, from mosses and carnivorous plants such as Venus Flytraps and sundews to sedges and exquisite orchids (Rezendes 1996).

Swamp forests, often lining rivers, were once extensive in many parts of the world, providing habitat for water birds, mammals, amphibians and other wildlife, while preventing floods. In the United States, such forests once covered the shorelines of the Mississippi River and millions of acres in southern states. Deposits of soil from flooded rivers provide nutrients and anchoring for trees and plants. Most of these swamp forests were cut and replaced with agriculture by settlers, and today the region is plagued by floods.

Migratory aquatic animals need several types of habitats during the year. Salmon live in the open ocean but spawn and die in freshwater streams and rivers where the next generation hatches. Cranes and other water birds feed and breed in both salt and freshwater marshes, while using other types of wetlands during migration. Wetlands and surrounding ecosystems, such as woodlands, interact to provide habitat for many types of wildlife. When trees bordering wetlands are cut, this can adversely affect the water flow and wildlife living in wetlands. Some kinds of toads, for example, need both wetlands, such as ponds or lakes where they lay their eggs, and woodlands, where they seek out damp areas to spend most of the year. Thus, when considering the protection of wetlands, the neighboring environments must also be preserved.

Salt marshes in the tropics produce great quantities of plant matter. A reed marsh can produce many times more vegetation than the most fertile grasslands, and some can out-produce an average American wheat field by eightfold (Lean and Hinrichsen 1992).

Mangroves line almost 75 percent of the world's tropical shores (Mydans 1996). They are important in creating conditions for sea grass and coral reefs that are extremely productive ecosystems. Some 50 species of mangroves and related salt-tolerant trees and shrubs grow in silt-laden coastal waters in tropical latitudes (Ripple 1995). Mangroves are pioneer species Œ they create new land. By setting down shoots into the sand or mud, they gradually trap sediment

and create soil. These trees' ability to survive in saltwater allows them to colonize coastal areas where no other type of land tree can live. Anchored by roots in mud, they absorb oxygen through breathing roots that grow in the open air above the mud, enabling them to survive in soils devoid of oxygen.

As they grow, they produce new rootlets at successively higher levels above the high tide level (Collins 1990). Old mangrove trees have huge, above-water roots that form a network of hanging branches, and their trunks grow from the new land created. Their fallen leaves decay and provide food for fish and shrimp. The hanging roots become overgrown with an array of algae, sponges, barnacles and mussels, providing shelter for crabs, fish and shrimp, while the upper branches are used by water birds for perching and nesting. Alligators, crocodiles, manatees, young sea turtles and dolphins find refuge here. Sediments are held in place by mangroves, preventing clouding and silting of waters farther offshore so that dense mats of sea grass can flourish, providing shelter for fish, crabs and other marine life. These, in turn, further stabilize the sediment and allow formation of coral beds in clear water further offshore (Luoma 1993). These three ecosystems--mangroves, sea grass and coral reefs Œ often exist together, each helping create an environment for the other. Mangrove forests also buffer coasts from wave action, preventing inland floods. Bangladesh and other countries that have cut their mangroves have been inundated by disastrous floods, causing great loss of human life and property.

Oceans are vital in recycling important elements that represent the basic building blocks of living organisms: carbon, nitrogen, oxygen, phosphorus and sulphur (Daily 1997). Phytoplankton living in marine environments produces between 33 and 50 percent of the world's oxygen supply while absorbing vast amounts of carbon dioxide (Brown 1994). Oceans are the most important factor affecting the world's weather patterns. In turn, they are affected by changes in world temperatures, such as global warming, which create extreme weather from droughts to torrential rainfalls on land. This vast realm is of vital importance to human survival, yet we are only beginning to learn about its role in preserving life on Earth and its ecology, life forms and ecosystems. We have found an increasing use for many of its species for medicine and industry, and each year, new, useful compounds are isolated from marine animals and plants. Although the biological diversity of the ocean is known to be great, research is poorly funded and lags far behind the research on possible life forms on Mars, for example. The latter project consumes billions of dollars while oceanic creatures are fading into extinction prior even to being named.

Corals are among the oldest ecosystems, with a residence on Earth of at least 450 million years (Wells and Hanna 1992). Many reefs have been growing in the same place for millions of years. Glovers Reef off the Belize coast in the Caribbean rises 6,000 feet from the sea floor and began developing about 20 million years ago (Carter 1997). Coral reefs occur in a band approximately 30 degrees north and 30 degrees south of the Equator. Reefs buffer shorelines from ocean waves and in turn prevent erosion, as well as provide quiet waters for sea grasses to grow closer to shore. These grasses, in turn, are fed on by endangered manatees, sea turtles, fish and shellfish. Species diversity, a key to ecological stability on Earth, is very rich in coral reefs, rivaling that of tropical rainforests (Wells and Hanna 1992). The diversity, beauty and productivity of coral reefs make them vital ecosystems to conserve, yet they are in extreme danger of disappearing within the next century. They are the most endangered aquatic ecosystem on Earth.

Coral reefs cover 360,000 square miles, an area equal to only 0.3 percent of the world's oceans and smaller than British Columbia, yet an estimated 25 percent of the world's marine fish species live here (Chadwick 1999, Zuckoff 2000b). The greatest diversity of coral grows in the Pacific and Indian Oceans, in the Indonesian-Australian region where at least 450 species are found (Doubilet 1999). Corals have evolved into many forms. Among the many forms of coral, brain coral is nearly round, while elkhorn grows great branches, and delicate black coral forms thin strands in deep water. Surrounding most mainland and island masses in these regions, corals also populate shallow areas far offshore, as in the Red Sea. The world's largest coral reef, Australia's Great Barrier Reef, runs for 1,400 miles along the northeastern coast of that continent. Up to 3,000 species of plants and animals inhabit a typical Asian coral reef, and more than 1,000 live in Caribbean reefs (Wells and Hanna 1992). They are an oasis of life in warm waters which, in contrast to cold waters, are often poor in nutrients (Doubilet 1999).

Some coral has been found to be 800 to 1,000 years old, based on annual growth rings (Wells and Hanna 1992).

Growing very slowly, often less than 1 inch a year, the coral communities are made up of thousands of individual animals. Hard coral secretes calcium carbonate, a substance that becomes as hard as concrete (Doubilet 1999). When corals die, another generation grows on their skeletons, creating gigantic underwater structures that can grow for millions of years.

About 2,000 species of fish inhabit Southeast Asian reefs, and worldwide, between 4,000 and 5,000 fish species have been found in coral reefs so far (Wells and Hanna 1992), including starfish, sea urchins, sea cucumbers, crustaceans and mollusks in an incredible array of forms and colors, some resembling feathery anemones, others boldly striped to warn of poison. Many squeeze into crevices in the corals, creating a tapestry of textures and hues. On the Great Barrier Reef alone, some 4,000 species of mollusks are found, including sea slugs, clams, snails and hundreds of species of cones, trumpet shells, cowries and scallops (Wells and Hanna 1992).

Coral reefs provide habitat for many endangered species. Sea turtles find food and shelter here. The now endangered Hawksbill Turtle (*Eretmochelys imbricata*) was once commonly seen in coral reefs around the world, feeding on sponges and invertebrates (Wells and Hanna 1992). Large numbers of sea birds live on the fish produced in coral reefs, and many sea birds nest on islands around the world that are surrounded by coral reefs. In recent years, coral reef ecotourism has increased. Tourists now gaze at the reef wonders through glass-bottomed boats and scuba masks, generating a new source of income for many countries. Tourism accounts for 55 percent of the Gross National Product of the Bahamas and is playing an increasingly important role in other tropical countries. Tourism is a major incentive for countries to enact strict legislation protecting their marine environments.

Ocean creatures have proven valuable to medical research, supplying compounds that treat inflammations, asthma, heart disease, tumors, infections, viruses and pain (Chadwick 1999). Sea animals, such as cone shells, sea snakes and stonefish, contain some of the most toxic poisons in nature. Such compounds are offering non-addictive solutions to the treatment of pain and other medical problems. Some chemicals in sponges and sea slugs may be useful as insecticides, and coral itself is being investigated for possible use in bone grafts (Chadwick 1999). Glucosamine, a compound found in the shells of crabs and related animals, has proven to be extremely effective in treating osteoarthritis, controlling both pain and the progression of the disease which destroys cartilage. It seems to be a building block for cartilage and has been used safely in Europe for generations. This nutritional supplement has been tested by the Arthritis Foundation in clinical trials, after which it endorsed the use of Glucosamine for osteoarthritis. Finding new treatments for disease, and substances that can be used as glues obtained from barnacles, are among other ocean-based useful products. Future discoveries will depend on a healthy ocean that maintains its diversity.

Likewise, other types of sea and coastal ecosystem tourism have prospered in recent years. Whale watching has become a $1 billion industry worldwide, according to a 2000 study by the International Fund for Animal Welfare (BG 2000). At least 87 countries sponsor whale watching trips in 500 communities, allowing 9 million people to view these great mammals in 1998 (BG 2000). Cruises to Alaska, sport fishing, bird watching, hiking and other activities in non-tropical and freshwater destinations have also become far more important sources of income than resource extraction in many areas. The effects of the latter industries, including oil pollution, sedimentation from logging and pollution from mining, have decreased their income potential while destroying these precious ecosystems.

Destruction of Aquatic Ecosystems

As aquatic habitats are destroyed bit by bit, countless creatures and plants disappear. Crystalline bodies of water that furnished ample water to wildlife and people alike only a few centuries ago have become polluted or dried up. Growing human populations and development consume millions of acres of ecologically important coastal marshes and mangrove swamps to make way for airports, urban development, seaports, shrimp farms and resorts. More subtle changes are occurring from ozone depletion, acid rain and global warming caused by chemical pollutants in the

atmosphere. These may end in far-reaching ecological changes and extinctions that are only beginning to be chronicled.

Less than 3 percent of the Earth's water is fresh, and two-thirds of it is frozen in glaciers and ice caps. The remaining 0.5 percent is contained in aquifers, rivers, marshes, other wetlands and in the atmosphere (Barlow 1999). Global population growth is expected to outpace freshwater supplies by 56 percent by 2025 unless patterns of use change radically (Barlow 1999). Water use has grown at more than twice the rate of population increase in the 20th century, according to the United Nations (Barlow 1999). Almost 70 percent of the world's population lives in areas bordering bodies of water such as rivers, coastlines and lakes, where civilizations have traditionally arisen (Dugan 1993). The United Nations reports some 80 countries, 40 percent of the world's population, are already facing water shortages (Lewis 1996). At least 20 percent of the world's peoples do not have clean water for drinking, according to a 1997 conference of Earth Summit Plus (Grossfeld 1997). Cities have been increasing in size, and the United Nations predicts that within a decade, most of the world's peoples will live in cities for the first time in the human history. Currently, 2.6 billion people live in urban areas; this total is expected to rise to 3.3 billion by 2005 (Lynch 1996). By 2025, 5 billion people, or almost all people now living on Earth, are expected to be city-dwellers, the vast majority in poor countries without effective pollution control or sufficient water supply, by UN estimates.

The United Nations believes that by 2025, the world's population will number 8.3 billion, with two-thirds living in conditions of serious water shortage and one-third suffering from severe water scarcity (Barlow 1999). Growing urban populations require more and more fresh water. Rivers and lakes have been dammed, diverted and channeled to supply these cities, often with disastrous consequences for wildlife. Since all portions of a river are part of the same ecosystem, when it is dammed or altered, the river and its wildlife and plants are affected throughout its length, which may extend over 1,000 miles. Wetlands at the mouth of a river can be drained by the construction of a dam hundreds of miles inland. Likewise, channeling at the mouth of a river, increasing flow for ship navigation, can drain wetlands and alter flow for the entire length of the river, eliminating native wildlife and plants. The Missouri River, for example, was once a shallow, sandy-bottomed river lined with trees and swamps. When Lewis and Clark explored the region in the early 19th century, they saw great numbers of sturgeon, trout and other fish, aquatic mammals, and vast flocks of cranes, waterfowl and shorebirds. During the 20th century, multiple dams were built, and the river was channeled to accommodate ship traffic, radically altering the Missouri's ecosystem. The shallow-water feeding grounds for birds were drowned, and migratory sturgeon and trout found their routes blocked, endangering many species. After much opposition from barge operators and farmers, Congress funded a program in October 2000 to partially restore the flow to accommodate the needs of native wildlife by altering water releases from dams for a few months each year. Many conservationists are working to save even more of this original ecosystem.

Underground aquifers contain water that has been accumulating for thousands of years**.** Only in recent decades have they been exploited, and many are being over-pumped for city water supplies or agriculture. The High Plains Ogallala aquifer in the Great Plains of the United States stretches from South Dakota to Texas; pumping is depleting it eight times faster than it can be replenished naturally (Barlow 1999). This story is being repeated around the world, especially in desert regions such as North Africa, northern China and the Saudi Arabian peninsula, where fossil aquifers are being over-pumped for agriculture, industry and household use (Barlow 1999). This is resulting in their gradual depletion, contributing to a future "water bankruptcy" (Barlow 1999). Countries in arid regions are already competing for scarce water supplies. The Euphrates River has been dammed by Turkey, turning its flow to a trickle by the time it reaches Iraq. The latter country has become increasingly arid over the past few thousand years as grassland and bountiful water supplies deteriorated to desert as a result of over-use of water and drainage of wetlands.

Trade treaties, such as the North American Free Trade Agreement (NAFTA) signed between the United States, Canada and Mexico and the World Trade Organization (WTO), whose members include the majority of countries, override national water rights, assigning them to corporations and other commercial interests. Water is now being bought and sold as a commodity. One large company, the US Global Water Corporation, has signed an agreement with Sitka, Alaska, to transport 18 billion gallons of glacier water per year to China, where it will be bottled and sold

(Barlow 1999). A California company was denied the ability to purchase water from British Columbia and, under the principles of NAFTA, sued the government of Canada for $220 million (Barlow 1999). Environmental and species preservation are not considered in these global transactions. By treating water as a commodity to be traded to the highest bidder, ecosystems will be devastated. The International Forum on Globalization of San Francisco outlines many of these issues that point toward future catastrophes for the environment and human society alike in its report, *Blue Gold*. It concludes that only if water is considered to be commonly shared by humans and all species, and water diversion, damming, pollution, sale and bartering are halted, can there be hope for the future (Barlow 1999).

In the United States, only the onset of droughts brings about restrictions on water usage. Agriculture and livestock use an estimated 65 percent of the country's water supplies, households 10 percent and industry 25 percent. Much of the water used for agriculture comes from diverted rivers in irrigation programs which return it to water tables contaminated with large amounts of pesticides, herbicides and artificial fertilizers. An American family of four uses 300 gallons a day, far more than the average in most of the rest of the world. This profligacy has been at the expense of natural ecosystems. As human populations grow, water use will result in ever more strain on water supplies. Cities have sprung up in near-desert regions in the United States, requiring water diversion from other areas. One of the most dramatic examples of this is Los Angeles. The major flows from several rivers and lakes have been diverted to supply the needs of Los Angeles (Reisner 1986). Only with artificial water supplies has this city been able to grow to metropolis size. Its denizens waste their water supply to grow green lawns, and an enormous amount is used by local industry and agriculture. Los Angeles' water has been supplied at the expense of wildlife and plant species native to the diverted and drained water bodies, many of which are now endangered (Reisner 1986). Salmon and other fish have become endangered in the source rivers and lakes used to supply Los Angeles. Las Vegas, Phoenix and other western cities also tap the scarce water resources of the West. The diversion of water from natural rivers and lakes for large cities and massive agriculture projects is destroying aquatic oases in dry areas and drying up entire rivers in deserts, endangering species as diverse as tortoises, Bald Eagles (*Haliaeetus leucocephalus*) and songbirds.

Half of the people in developing countries suffer from illnesses associated with contaminated water, such as chronic diarrhea (Grossfeld 1997), and more than 5 million people, most of them children, die every year from these illnesses (Barlow 1999). Conflicts over water resources between countries and states are increasing, and in the future, wars may be fought over dwindling water supplies.

Although marshes are able to filter limited amounts of nutrient-laden water, raw, untreated sewage dumped into waterways can turn them into fetid, oxygenless mires. Ninety percent of the sewage in the swelling cities of poor countries is untreated, having had none of the solid matter removed, according to the World Resources Institute in Washington, DC. Some rivers, such as the Ganges and Brahmaputra River systems, are so polluted that the native dolphin, the endangered Ganges River Dolphin (*Platanista gangetica*), struggles to survive in the contaminated water. Fish are killed by the pollution, leaving the dolphins without food, and the high bacteria counts may be killing these dolphins directly. The Ganges has become so sewage-laden that it presents major health risks to the people who drink from and bathe in its water. This is especially ironic because this river is a holy river to the millions of Hindus who come to anoint themselves in its water. India has more than 3,000 towns and cities, but only eight of these have sewage treatment plants (Crossette 1996). Even sewage treatment systems can overflow during heavy rains, spilling toxic chemicals and oily runoff from roads, as well as untreated sewage. Since almost half of the world's population lives in cities, this is one of the world's most serious environmental problems.

The failure to conserve forests and vegetation has become a major factor in destroying natural aquatic ecosystems around the world. Besides causing mud slides and floods, the cutting of trees bordering rivers and streams also results in a rise in water temperature that affects the local climate and kills fish eggs and other wildlife. Clear-cut logging also causes siltation of rivers and lakes, smothering fish and wildlife. Salamanders, who require damp, undisturbed forest floors, are often eliminated by clear-cut logging. James Petranka of the University of North Carolina estimates that in the national forests of North Carolina, 14 million salamanders are wiped out every year by clear-cutting (Stolzenburg 1997). Extreme deforestation causes streams, springs, ponds and rivers to dry up and the regional climate to become more arid.

Oceans were once thought resilient to heavy pollution and the dumping of all types of debris. We are learning, however, that the combined effects of overfishing, killing of coral reefs and toxic contamination are turning them into aquatic deserts, according to Dr. Sylvia Earle, an eminent oceanographic scientist, and conservationist-author, Carl Safina (Earle and Henry 1999, Safina 1997). The oceans have also become crowded with commercial ships, fishing boats and pleasure craft, all of which are causing problems for wildlife. These ships discard plastics and other material and pose a threat of collision. Several cruise lines have been indicted and fined in recent years for dumping illegal materials overboard, including plastics, large amounts of waste oil and other toxic substances.

Coral reefs have proven very delicate and vulnerable to die-offs. Pollution, overfishing, cyanide poisoning and dynamiting to obtain tropical fish for the aquarium and Asian restaurant trades, or corals for the curio trade have all contributed to severe losses in the 70 million square miles of coral reef around the world.

Natural, unpolluted aquatic environments are fast disappearing around the world. Approximately 50 percent of the world's wetlands have been lost in historic times, according to *Wetlands in Danger: A World Conservation Atlas* (Dugan 1993). In the past, wetlands were destroyed primarily for agricultural development. Although this remains a major threat, programs such as dam construction and irrigation projects financed by the World Bank and the International Monetary Fund are becoming the major threat to pristine aquatic environments around the world. Unfortunately, the effects of these losses are usually appreciated too late, when species disappear and water ecologies are damaged.

Soils in many dryland areas have become polluted by salinization caused by irrigation schemes. Irrigation water flowing onto drylands brings to the surface substratum minerals and salts, which render the soil unfit for agriculture or almost any natural vegetation. Regions covering at least 150,000 square miles worldwide have become too saline to farm after irrigation programs (Dugan 1993).

Threatened Species

Approximately 41.4 percent of the 5,435 animals listed by the 2000 IUCN Red List, 2,251 species, are native to aquatic environments. Many more are in lower categories of threat such as near threatened or possibly threatened. Of these, 88 percent are native to inland or freshwater. At least 790 species of fish are threatened with extinction, 627 of these native to freshwater. This is an indication of the effects of dams, pollution and introductions of non-native fish that out-compete native species. Reptiles, totaling 111 species, are threatened by habitat destruction through wetland drainage and pollution, as well as demands of the pet, meat and skin trades that are pushing a growing number of turtles, crocodiles, chameleons and other lizards toward extinction. The threats to amphibians, especially frogs and toads, have grown dramatically in recent years, with environmental factors, such as UV radiation from ozone thinning, pesticide use, wetland destruction and pollution, playing important roles.

(Higher Categories of Threat)

	Marine	**Inland Water**	**Total**
Mammals	25	31	56
Birds	105	78	183
Reptiles	9	111	120
Amphibians	0	131	131

Fish	163	627	790
Crustaceans	0	408	408
Insects	0	125	125
Mollusks	13	420	433
Corals & Anemones	2	0	2
Worms	3	0	3
Total Animals	320	1,931	2,251
Plants	0	14	14
Grand Totals	320	1,945	2,265

Based on 2000 IUCN Red List of Threatened Species Compiled by Craig Hilton-Taylor. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland, Cambridge, U.K.

The number of threatened whales, dolphins, porpoises, manatees and seals has greatly increased in recent years. Moreover, many species have been upgraded in status to more endangered categories. Pollution, killing for meat and drowning in fishing nets play roles, but clearly more research needs to be carried out as to whether there is sufficient food for the large whales, such as the Blue, Fin, Sei, Gray and Northern Right Whales, none of which has recovered from past whaling. In the early 1980s, the IUCN, in its various Red Data Books, listed only three species of dolphins and six whales as threatened. In the 2000 IUCN Red List, 25 dolphins, six porpoises and 35 whales are listed in various categories, a dramatic increase. Marine ecological systems are becoming imbalanced as a result of overfishing. Gray whales have been washing ashore dead in unprecedented numbers on the North American Pacific coast. Many are thin and appear to have died of starvation, either from overfishing of their food supply or effects of changes in ocean temperatures brought about by El Nino or La Nina, which can greatly alter the types of fish remaining in an area. Destruction of sea beds is caused by fishing trawlers who rake sea beds for scallops and groundfish, obliterating entire communities of anemones, starfish, sea grass and habitats for a variety of fish and invertebrates.

A major increase in the number of threatened sea birds has also occurred. The number of threatened albatross has risen from two in the early 1980s to 20 in recent years. Similarly, only two species of penguins were threatened in the early 1980s, while 12 were listed in 2000. Petrels, small nocturnal sea birds that were once abundant, had 12 threatened species in the 1980s, mainly from disturbance of their nesting islands. At present, more than 40 species of petrels and storm-petrels are threatened with extinction. A major cause is long-line fishing for tuna, swordfish and other billfish, with baited hooks that attract albatross and petrels. Sea birds and birds that live along coastlines, lakes and rivers have been endangered by marsh drainage and pollution, human encroachment on their nesting habitats and invasions by exotic species of plants and animals.

The vast majority of threatened fish listed by the IUCN are freshwater species, but this may be an indication of our ignorance about the status of marine fish. The 1990 IUCN Red List included 751 species of fish in various categories (WCMC 1990). That number rose to 979 in 1994 (WCMC 1993), and in the 1996 IUCN Red List, 1,091 species were listed in all categories. The compilers of the 1996 edition of the IUCN Red List noted that only a small portion of the world's fish have been evaluated in terms of their status, and almost no marine species have been researched (Baillie and Groombridge 1996). The 2000 IUCN Red List listed 752 species in its three highest categories, an increase of 18 species from 1996. Worldwide, the status of the majority of fish has not been appraised. Ignorance of marine fish populations has contributed to their depletion in commercial fisheries, which are pushing many species toward extinction (see Trade chapter).

North American freshwater fish are perhaps the best known in terms of the status of the world's fish because of long-term biological studies and the state Natural Heritage Programs, which have a data bank of rare, endemic, declining and imperiled species. Two reports compiled by The Nature Conservancy, 1997 Species Report Card: The State of US Plants and Animals (Stein and Flack 1997) and the book Precious Heritage: The Status of Biodiversity in the United States (Stein et al. 2000), were based on data from the Natural Heritage Programs in all 50 states. The organization found that 16 species of United States fish have become extinct in recent times, and one species is possibly extinct; 93 species are critically imperiled, 88 species are imperiled and 116 are vulnerable. This total of 314 species comprises 36.1 percent of all American fish, which makes for an extremely high rate of endangerment (Stein and Flack 1997).

A major threat to native fish in the United States is the introduction of non-native species, usually game fish such as exotic trout, by state fish departments. Rainbow trout, for example, have been introduced in areas where they are not native, and have out-competed and endangered native cutthroat trout in the West, as well as introduced disease caught in fish hatcheries. Few other countries have undertaken such detailed studies of endangered native wildlife, but in countries where freshwater ecosystems have been greatly altered by channeling, diversion, dams and pollution, research would likely find similar rates of endangerment. In China, 80 percent of major rivers are so degraded they no longer support fish (Barlow 1999).

Frogs and toads represent the most dramatic rise in threatened species of any vertebrate. Their plight may be indicative of the serious environmental threats facing the Earth. Because of their thin, porous skin, frogs are extremely sensitive to environmental contaminants. Within the past few decades, a large number of frog and toad species have disappeared all over the world. Many have been found with grotesque deformities and diseases. What is happening to the frogs appears to be an early warning of serious threats to the Earth's aquatic ecosystems and to its atmosphere. The scale of the recent disappearance of frogs around the world has not been seen since mass extinctions that occurred millions of years ago. The ecological effects will be significant because of their important role in consuming insects and as food items for a large number of animals, from birds to reptiles.

In the 1979 IUCN Red Data Book of Threatened Animals, a world review found 18 species of frogs and toads to be in various categories of peril; in the 1990, the number of threatened frogs and toads had almost doubled to 35, and in 1994, 130 species were listed Œ more than triple the previous total (WCMC 1993). The 141 species in various categories in the 1996 IUCN Red List represented a fourfold increase since 1990 and an almost eightfold increase since 1979. This total grew to 173 frogs and toads in all categories in the 2000 IUCN Red List, with 112 in the three highest categories of threat. Thus, threatened frogs and toads have increased 10 times in number from 1979, a trend not seen in any other large group of vertebrates since such studies began.

The threats to these amphibians are not regional. Frogs are threatened wherever they exist, declining in 140 countries, with status research continuing (Stolzenburg 1997). A worldwide phenomenon is occurring, endangering amphibians and causing extinctions at a spiraling rate. Among the first to disappear were two newly discovered and highly unusual frog species that had been acclaimed as remarkable by scientists around the world. These frogs came from the rainforests of Australia and had astounded the scientific world with their breeding biology. Their life history was so extraordinary that the man who first described it had his paper rejected by a prestigious journal for being implausible. Michael J. Tyler, associate professor of Zoology at the University of Adelaide, discovered these species, known as gastric brooding frogs (Rheobatrachus silus and Rheobatrachus vitellinus), and was beginning research on potential applications of their amazing ability to turn off gastric acids to the treatment of human stomach ailments. These frogs were filmed before their disappearance, which documented that they swallow fertilized eggs that grow in the female's stomach and emerge six weeks later as tiny froglets when she opens her mouth (Yoffe 1992). In 1980, only a few years after their discovery, this species and others in the area vanished; they have not been seen since (Yoffe 1992).

The dazzling golden toad (Bufo periglenes) also disappeared suddenly. Jay M. Savage of the University of Miami

came upon this species, native to the cloud forests of Costa Rica, in 1964 in Monteverde Cloud Forest Reserve, witnessing large gatherings of males during the breeding season (Phillips 1994). National Geographic Society filmmakers, in making the film, fiRainforest,fl recorded the assemblages of hundreds of these colorful toads perched on rocks among misty streams, and also filmed their far less flamboyant mates. Less than 2 inches long, male golden toads were bright, shiny orange, in contrast to the slightly larger females who were dark olive to black with spots of red encircled by yellow (Phillips 1994). Depicted on tourist posters and protected in its reserve, the Golden Toad's future seemed assured. No studies were carried out to discover its haunts during the rest of the year, however (Phillips 1994). Tourists flocked to Monteverde, many drawn to see the beautiful toads. In 1987, an American biologist, Martha Crump, witnessed the last breeding group of golden toads. "They've been described as little jewels on the forest floor, and that's really the impression you get," she recalled years later (Phillips 1994). With a grant from the National Geographic Society, she returned in 1988 for two seasons of research (Phillips 1994). In 1988, only 10 toads were seen, and only one male was in the breeding area; in 1989, only one toad was seen (Phillips 1994). None have been seen since (Yoffe 1992); the protected area was enlarged to 26,000 acres in the early 1990s to preserve as much forest as possible.

Two other inhabitants of this cloud forest, a species of translucent glass frog (Yoffe 1992) and an endemic harlequin frog (Stolzenburg 1997) have become very rare. A total of 20 other frog species are also missing from this region, based on a survey of Monteverde by a University of Miami biologist in 1996 (Blakeslee 1997). In Ecuador's high Andes, an estimated 50 species of frogs have disappeared since 1990. In Puerto Rico's rainforests, 12 of 18 endemic frogs are extinct or nearly so (Stolzenburg 1997).

The first World Congress of Herpetology, for the study of reptiles and amphibians, convened in 1989, and many of the 1,300 participants began comparing notes on the shocking fact that the subjects of their research were disappearing from under their very eyes. A comprehensive study was undertaken under the guidance of the IUCN's Declining Amphibian Populations Task Force (DAPTF) (www.open.ac.uk/daptf) to standardize methods of study of amphibian population changes and the environmental factors that may be affecting amphibian reproduction and survival (Stebbins and Cohen 1995). The 1989 conference inspired a symposium the following year that addressed this problem, recruiting 1,000 researchers in 40 countries. The reports from these researchers are published in a bulletin known as the Froglog, published by DAPTF on its website.

What is happening to the world's frogs? Many of the traditional causes still contribute to declines in amphibian populations. Marshlands and boggy areas continue to be filled in and polluted; pesticides, herbicides and other toxic chemicals are entering aquatic ecosystems, causing mortality and mutations. Introduced predatory fish and even exotic frogs have eliminated some frog populations (Yoffe 1992). Trade in frogs for the gourmet food market and for high school biology dissections has also played a role in the declines of some species. Some tropical frogs are known to have succumbed to a protozoan, which kills many and weakens the immune systems of others, making them vulnerable to a host of other pathogens (Blakeslee 1997). The disappearing frogs are not all from polluted areas. Some are native to remote wilderness areas, national parks and other pristine areas. The most surprising possible cause for their disappearance is the increased ultraviolet (UV) radiation resulting from the thinning of the ozone layer. This has been the subject of much research. The thinning of the Earth's ozone layer is caused by Chlorofluorocarbons (CFCs), chemicals used as coolants, aerosol propellants and for other industrial purposes. When released into the atmosphere, they turn into chlorine and destroy the thin-but-vital layer of ozone that shields the Earth from harmful UV radiation. Chlorine-based solvents have also had this effect. First noticed in the 1970s and early 1980s when holes appeared in the ozone layer at the Earth's poles, many years passed until the cause was proven. Those who discovered this phenomenon were awarded the 1995 Nobel Prize in Chemistry, marking the first time this prize was ever awarded for achievement in environmental science. The recipients were Dr. F. Sherwood Rowland of the University of California, Dr. Mario Molina of the Massachusetts Institute of Technology and Dr. Paul Crutzen of the Max Planck Institute for Chemistry in Germany.

Holes and thinning of the protective ozone layer have allowed an increase in the amount of injurious ultraviolet rays reaching the Earth, which has brought about a dramatic rise in the number of human skin cancer cases, as well as

declines in amphibian populations. Although the use of CFCs has been banned in new appliances and air conditioners in the United States, the chemical is still used in older cars and refrigerators, escaping to the air from malfunctioning units and improper disposal of these appliances. Illegal CFC imports into the United States have been documented, and some countries still allow their use. CFCs will take at least a century to disappear from the upper atmosphere, according to scientists.

In 1996, Yale University researchers made a discovery that may help stem the breakdown in the ozone layer. A chemical extract obtained from rhubarb and related plants, sodium oxalate, can chemically break down CFCs when heated to 520 degrees F. (Sharkey 1997). The practical use of this discovery is years away, but it may prove to be effective in controlling this lethal phenomenon.

As ancient bridges between land and sea, amphibians were named from the Greek words amphi and bio, meaning living a double life, indicating they were both aquatic and terrestrial. Frogs and salamanders are the only two major groups of amphibians, and they form an evolutionary link between fish and reptiles. First emerging in the Triassic period 200 million years ago, frogs have outlasted dinosaurs, and until recently, most biologists considered them hardy and adaptable species (Yoffe 1992). The vast majority of the approximately 4,100 species live in tropical areas. They must hibernate to survive cold, temperate winters, and relatively few species have evolved this adaptation.

The breeding biology of frogs and toads is a fascinating study in variety. There are frogs that develop marsupial pouches like tiny kangaroos to carry their fertilized eggs, and species in which the males incubate tadpoles in their vocal sacs until they emerge (Stebbins and Cohen 1995). The parent of one tropical frog hops across the forest floor carrying a single tadpole sticking with a mucus to its back; it climbs a tree and steps into a bromeliad plant, placing the tadpole into a tiny amount of water (Roberts 1996). The female returns to lay unfertilized eggs for the tadpoles to eat; she must remember which bromeliads, of the thousands in the area, contain her tadpoles. When the female enters the bromeliad containing her tadpole, it instinctively wriggles, causing vibrations in the water which stimulate the mother to lay eggs for it to eat (Roberts 1996). Wendy Roberts, a biologist who has studied the many reproductive methods used by tropical frogs, believes that as long as frog populations do not continue to disappear, more discoveries of the extraordinary variety of their reproductive biology, parental care and behavior will be made (Roberts 1996). Some toads have even adapted to desert mud holes by burying themselves and entering a torpor-like state until it rains again.

The decline of North America's frogs and toads afflicts fully one-third of the 86 species (Yoffe 1992). Their disappearance in wilderness areas was documented as early as the 1970s. David Bradford, a biologist now with the Environmental Protection Agency, studied the Yosemite toad (Bufo canorus) and Mountain yellow-legged frog (Rana muscosa) in Yosemite National Park in the 1970s at 26 sites. When he returned in 1989 and visited each site, he found frogs had disappeared from all but one site (Yoffe 1992). A 1992 survey concluded that three of the eight toads and frogs native to the Yosemite region have nearly disappeared: the red-legged frog (Rana aurora), which has since been listed on the US Endangered Species Act; the Foothill yellow-legged frog (Rana boylei); and the Great Basin spadefoot (Scaphiopus intermontanus) (Yoon 1996). The Yosemite toad declined or disappeared at nine of the 13 original sites where a 1915 survey had found them abundant (Yoon 1996). Because of the longevity of toads, some living to be 35 years old, declines may go unnoticed as long as adults are alive, even though all their offspring may be dying year after year. Stebbins and Cohen (1995) documented declines in a number of once-common species in their text, A Natural History of Amphibians. Northern leopard frogs (Rana pipiens) and nine other species have become rare or absent in former haunts (Tyning 1995). The latter species has been dissected by the millions in high school biology classes, many of which require the students to kill the frogs, often by cruel means.

Dr. Andrew Blaustein, a herpetologist at Oregon State University, studied the Western toad in lakes in the Cascades Range at 4,000 feet for many years. By the mid-1980s, he found that these toads were becoming rare, yet in the same habitat, Pacific tree frogs (Hyla regilla) seemed to be thriving (Blaustein 1994). Female Western toads produce 12,000 eggs in long strips that are laid in unshaded ponds, and then they disappear into the forest, leaving the eggs to hatch in the shallow water (Blaustein 1994). Dr. Blaustein began to find eggs that did not develop properly, turning white, and

then dying and leaving a fetid, viscous mass (Blaustein 1994). Other amphibians of these mountains, the Cascades frog (Rana cascadae) and the red-legged frog, had also disappeared completely from most of their range (Blaustein 1994).

Dr. Blaustein and a colleague decided to conduct outdoor and indoor experiments to test the reactions of frog eggs to ultraviolet radiation. Trays of frog and toad eggs in water were placed outdoors, and some were exposed to UV rays; others screened from UV-B rays, the most harmful type of radiation; still more eggs were brought into the lab and kept in darkened conditions (Blaustein 1994). Ninety percent of the eggs raised indoors, as well as those screened from UV rays outdoors, developed normally, while 40 percent of the unscreened eggs exposed to UV rays died (Blaustein 1994). Here was proof of the effect of present levels of UV rays. Dr. Blaustein and other biologists have concluded acid rain is combining with UV radiation in some areas to kill frogs and toads (Yoon 1996).

Some frogs and toads are dying of unknown causes. One biologist studying the Western toad (Bufo canorus) in a wilderness area in Colorado in the 1970s came upon dozens of dying toads, barely able to move because of their puffy red legs (Yoffe 1992). She took several of them to a veterinarian and was told their immune systems had collapsed, making them vulnerable to infection (Yoffe 1992). Biologists in Massachusetts have found wood frog (Rana sylvatica) tadpoles dying of disease outbreaks in three of four recent years (Knight 1995).

Grotesquely deformed frogs have been discovered recently in many parts of the United States. In 1995, a biology class found frogs with shocking malformations near Henderson, Minn. Some were missing both hind legs; others had as many as six legs, and at least one had an eye growing in its mouth. Another had a leg growing from its stomach. Many had only one leg, one eye, four tangled hind legs, misshapen limbs and tails, missing or shrunken eyes and small sex organs (Associated Press 1996). These deformed frogs were shown on national television news programs throughout the country. Researchers found similar frogs in 1996 and 1997 in California, South Dakota, Wisconsin, Vermont and Massachusetts, as well as in Quebec, Canada. Up to 35 percent of frogs in these areas may be deformed. Within a year, deformed frogs were seen in 54 of 87 counties in Minnesota. A herpetologist from the University of Minnesota at Morris examined 10,000 frogs in the summer of 1996, finding the greatest number of abnormalities in frogs that spent the majority of their lives in water, rather than coming to water only to lay eggs. Vermont's leopard frogs had a 45 percent deformity rate, and for the first time, deformed salamanders were found. Three five-legged salamanders were found in Massachusetts, an ominous sign this phenomenon is spreading to another type of amphibian.

At the Scripps Institute in California, laboratory tests on frogs produced similar deformities when they were exposed to the commonly used mosquito pesticide, methaprine. This chemical affects growth hormones, causing them to malfunction. In September 1997, officials of the Minnesota Pollution Control Agency announced they reproduced the deformities when frog eggs were raised in tap water from areas with deformed frogs. They issued a public health alert based on this research, providing bottled water to people living in these areas. One Minnesota biologist found internal and external abnormalities in these frogs. EPA studies found deformities when frogs were exposed to ultraviolet rays as well. These findings indicate certain pesticides and UV radiation present major threats to amphibians. Other studies have shown parasites can also cause deformities (Yoon 1999).*

North American researchers have organized the Great Lakes Declining Amphibians Working Group, as well as the North American Amphibian Monitoring Program, maintained by the US Geological Survey of the Department of the Interior. The FROGWATCH USA website gives advice to concerned citizens to learn more about aiding this situation. The US Fish and Wildlife Center provides information about the population status of various amphibians, as does AmphibiaWeb, run by noted herpetologist, Dr. George B. Rabb.

The disappearance of frogs and toads may seem insignificant to many people. From an ecological point of view, however, these animals play an important role in controlling insect populations. After frogs were nearly extinguished in Bangladesh to supply gourmet tables in France with frog legs, mosquito numbers and the incidence of malaria skyrocketed (Yoffe 1992). Frogs themselves are a major food item for a wide variety of animals, from storks to

raccoons. They are an important link in the food chain, and their extinctions may have a major effect on a wide variety of other species and even evolution itself (Yoffe 1992).

From a human health point of view, frogs and toads have proven to be the source of many valuable medical compounds. Dart-poison frogs of Central and South America are more terrestrial than species that spend their lives in water, and to protect themselves, they have developed some extremely potent poisons that they excrete through their skin. Natives have used these chemicals on the tips of their arrows for hundreds of years to kill prey as large as monkeys. These tiny, brightly colored frogs are being studied by the National Institutes of Health for the alkaloid compounds found in their skin, which are used in research on nerve and muscle function, and as anti-convulsants and anti-arthritics (Sharp 1995). Another compound found in the skin of an Ecuadorian dart-poison frog has 200 times the pain-killing power of morphine (Sharp 1995).

Preserving Aquatic Ecosystems

Only recently have some aquatic environments received protection in some parts of the world. New marine sanctuaries that protect coral reefs and other sea life have been set aside in a growing number of countries. In 1994, Australia, the United States and six other nations founded the International Coral Reef Initiative to encourage preservation of reefs endangered by pollution, overfishing and other causes. In the future, sanctuaries and international agreements will provide major means of conserving these ecosystems. Unfortunately, many of these sanctuaries allow commercial fishing and the collection of mollusks. The value of aquatic ecosystems in preserving biodiversity is only beginning to be appreciated, aided by the growing popularity of bird-watching, scuba diving and coral reef tourist visits that are educating many people about the importance of protecting these fragile ecosystems.

Private organizations and universities are playing important roles in monitoring and conserving delicate aquatic habitats. The International Marine life Alliance, based in the Philippines, is convincing fishermen to catch fish in hand nets, rather than poison or dynamite reefs. The Global Coral Reef Alliance is investigating diseases that are afflicting reefs through scientific research, and Greenpeace International has been active in conducting worldwide surveys of the deterioration of coral reefs. Depletion of species by overfishing and consequent imbalances in reef ecosystems and biodiversity are being undertaken in various parts of the world. A Canadian researcher, Amanda Vincent, who documented a dramatic decline in seahorses as a result of over-harvest for Chinese Traditional Medicine, has been working with Philippine fishermen to limit catch and set aside sanctuaries where stocks can increase. Woods Hole and Scripps Oceanographic Institutes are conducting important research in marine environments, studying subjects as diverse as the effects of US Navy sonar testing on whale behavior and deep- sea environments. Small and maneuverable submarines are now exploring deep- sea ecosystems, taking samples of new species and filming these extraordinary habitats. Almost all such research is funded by non-governmental organizations, since governments have yet to realize the importance of funding such research.

International efforts began as early as 1973 to control Marube debris and pollution when the International Maritime Organization, a United Nations agency responsible for shipping, formed an agreement known as MARPOL. This agreement regulated the disposal of oil and hazardous chemicals. In 1978, it was amended to include annexes on the disposal of hazardous materials, sewage, fishing nets, ropes, bags and trash. In 1988, the Marine Plastics Pollution Research and Control Act was enacted by Congress, prohibiting United States ships from dumping plastic items into the sea, and prohibiting foreign ships from disposing of plastics within 200 miles of the United States. Plastics include such items as nylon fishing nets. As of 1994, all US government-owned ships had to comply with all regulations, disposing of plastic waste at port. The National Oceanic and Atmospheric Administration (NOAA) has an interagency task force on marine debris, which has attempted to coordinate other federal agencies to reduce marine debris. The Environmental Protection Agency, with the Center for Marine Conservation, and NOAA coordinate

annual beach cleanups, which are now being carried out in some European countries as well as in the Middle Eastern country of Bahrain. Thousands of tons of plastic bags and fishing lines that might have washed back out to sea have been removed by these cleanups. The Marine Entanglement Research Program was established by NOAA in 1984 to study this problem.

As a result of international concern about the disappearance of irreplaceable wetlands, the Ramsar Convention was adopted in 1971. Each member country designates and accords legal protection for at least one wetland to be included in the *List of Wetlands of International Importance*. More than 600 Ramsar sites have been designated, covering 100 million acres. Some of these wetlands, in spite of designation, are threatened by government-sponsored plans. The Acheloos Delta in southwestern Greece may be diverted to produce electricity, and a huge flood-control plan threatens Lake Utonai in Japan. The Ramsar Convention has been instrumental, however, in protecting wetlands through international cooperation. The Wadden Sea, a wetland on the coasts of the Netherlands, Germany and Denmark with up to 12 million birds wintering, breeding or migrating through its land, is being protected through cooperative agreements among the three countries (Dugan 1993). These wetlands are not in their natural state after centuries of diking, filling and other man-made changes, but efforts are being made to maintain large areas of marshland and other wetland habitat.

The North American Wetlands Conservation Act of 1989 created funding to preserve wetlands in Canada, the United States and Mexico; since 1989, hundreds of projects have protected more than 1 million acres of wetland ecosystems in the United States and Canada alone. A prime area preserved by this act is Cheyenne Bottoms, the last sizeable wetland in Kansas, designated as a "Wetland of International Importance" by the Ramsar Convention, a Hemispheric Reserve by the Western Hemisphere Shorebird Network, and Critical Habitat for the endangered whooping crane (*Grus americana*). To date, 6,000 acres have been protected, 35,000 restored and another 13,000 acres of Cheyenne Bottoms enhanced (Graziano 1994).

Another important aquatic environment, the lagoons of Baja California, has been designated a Biosphere Preserve. Under great threat from a proposed salt factory to be constructed by Mitsubishi Corporation in the prime wintering lagoons of gray whales, conservationists succeeded in stopping the project in late 2000. This preserve also shelters sea turtles, many sea birds and other marine mammals. Mexico's laws did not permit such damage to an officially declared Biosphere Preserve, but it nevertheless took years of legal wrangling and the participation of many conservation organizations to achieve this victory.

National anti-pollution legislation in many countries is making some progress in bringing back rivers and wetlands that had become lifeless from heavy pollution. International treaties have also been negotiated for individual rivers. The Danube River flows 1,770 miles from its source in Germany to the Black Sea, and along its entire length, it has been diked, dammed and channeled to accommodate barge traffic (Cowell 1995). In Hungary, the river inspired the famous waltz of that name and has been severely damaged by dams and diversion on the Slovak side, which have shunted most of the water from one of Europe's wildlife havens. This 200 square mile area is one of Europe's last wetlands, sheltering some 5,000 species of flora and fauna, and Hungary continues to negotiate its return.

The Danube Delta on the Black Sea lies mainly in Romania and is considered one of the world's great wetlands, covering 2,200 square miles (Simons 1997). In the mid-1980s Romania's dictator, Nicolae Ceausescu, decreed that the entire delta be transformed into grain fields (Simons 1997). He succeeded in destroying about one-fourth of the delta, or 240,000 acres, converting the land into wheat and rice fields. Not only was massive wildlife habitat lost, but his men shot pelicans and cormorants because they were eating too many fish (Simons 1997). The drainage plan did not succeed because the delta soil was not conducive to these crops, and by the time Ceausescu was executed by firing squad in 1989, it had been abandoned (Simons 1997).

In 1991 the Danube Delta was declared a Biosphere Preserve, and a conservation plan was set in place; as a first act, dikes and dams were breached, allowing the flooding of more than 9,000 acres (Simons 1997). As a feeding and resting area for millions of migratory birds of 325 species, the delta is of global importance (Simons 1997). It is also a

major nesting area for many threatened birds, including the Dalmatian pelican (*Pelecanus crispus*), a bird that was once abundant throughout Western Europe (Hoyo *et al*. 1992). Today, it is confined to eastern Europe and east-central Asia, with approximately 4,000 to 5,000 breeding pairs; fortunately, as a result of strong conservation programs, massive declines have been stopped or slowed (BI 2000).

An ecotourist industry has sprung up in the Danube Delta, helping to fund further restoration (Simons 1997). Anti-pollution work will be needed to cleanse the waters of an overload of contaminants poured into the river by the eight countries through which it flows (Simons 1997). This is the world's first example of the restoration of a delta and is founded on the philosophy that land valuable as flood protection and wildlife conservation is worth more in its natural state than converted for human use (Simons 1997). Experts involved in Mississippi and Rhine River restoration have been interested in the Danube restoration, which may herald a new approach to this crucial habitat.

Sections of rivers have received protection under the Wild and Scenic Rivers Act. This law and the actions private organizations such as American Rivers have succeeded in altering the pro-dam and channeling viewpoint that long has dominated America. The International Rivers Network has also worked to oppose dams around the world, often with great success. On the local scene, River Network, an organization founded in 1988, works at a grassroots level to encourage citizens to help clean up and preserve rivers and watersheds. Its book, *How to Save a River: A Handbook for Citizen Action* (Bolling 1994), provides a blueprint for individual conservationists. The Water Keeper Alliance, first launched to save the Hudson River from heavy pollution, works on many rivers in the United States to test water for pollution and works through activists and lawyers to stop pollution problems (Cronin and Kennedy 1997). Teachers and their students in countless school districts have adopted streams and rivers, removing trash and debris, and restoring them to their original states, even reintroducing native fish.

Progress is also being made in the United States in restoring wetland ecosystems. The Everglades is America's largest wetland. It was a vast, unspoiled marsh, a wilderness of sawgrass, groves of Bald Cypress trees and vegetated hillocks until only a century ago. Fresh water flowed through the 7 million acre Everglades from the enormous, 733 square mile Lake Okeechobee and its feeder rivers to the north, ending in Florida Bay (Levin 1996). During the dry season, rivers threaded their way through the wetland, and in spring wet seasons, the entire region would turn into a shallow river of grass. At one time, more wading birds nested here than anywhere else in the country. Four hundred species of birds, 60 species of amphibians and reptiles, and 25 species of mammals have been recorded in the southern Everglades alone, and at least 120 species of trees and 1,000 species of seed-bearing plants are native (Rex 1996).

Giant century-old alligators (*Alligator mississippiensis*) prey on a diversity of fish, turtles and snakes. River otters (Lutra canadensis) and tiny white-tailed deer (*Odocoileus virginianus seminola*) are also native. The round-tailed muskrat (*Neofiber alleni*) is found nowhere else. This rodent, dependent on shallow, freshwater marshes, has been affected by the invasion of exotic plants that have taken over much of the Everglades (Layne 1978). The Everglades mink (*Mustela vison evergladensis*) lives south of Lake Okeechobee, far from other races of mink. These animals are aquatic, utilizing much the same type of habitat as the round-tailed muskrat, although they are far more restricted in range (Layne 1978). Both species have declined as a result of development, water pollution and reduction of acreage of the freshwater marshes (Layne 1978).

Settlers arriving in Florida in the 19th century saw only a "pestilence-ridden swamp." The US government drained the entire wetland for development and agriculture, building the first federal canal in 1881 with enthusiastic state support. In 1905, the Governor of Florida vowed to wring the last drop of water out of the Everglades, and state drainage programs supplemented federal projects. Congress passed legislation in 1947 that authorized a massive program to control the flow of the Everglades, ostensibly to prevent flooding; 1,400 miles of canals, dikes and levees were built to straighten and channel the meandering Kissimmee River, the major feeder of Lake Okeechobee, in order to divert water for sugar growers south of the lake (Levin 1996). Four canals drained the lake and lowered water level by 5 feet; 3 to 4 million acres of its water were diverted toward the Atlantic every year, water that once fed the Everglades (Levin 1996). South of the lake, 500,000 acres were drained for agriculture. The same year this project was authorized, a strong-willed newspaper reporter, Marjory Stoneman Douglas (1947), wrote *The Everglades: River*

of Grass, pleading for the preservation of this great wetland. She carefully researched the conservation importance of the Everglades and documented the folly of destroying it to appease the growing agriculture industry. The book remains a classic, and not until the 1990s did the country realize that the drainage project was a terrible mistake.

Half the wetlands that once made up the Everglades are gone, now replaced by farms, suburban housing, agriculture and highways (Levin 1996). Ninety percent of the water birds and most of the native mammals have disappeared. The southern Everglades have become increasingly saline from an influx of sea water, causing the disappearance of many species unable to adapt. Some of the overflow from canals during heavy rains has been pumped into the Micaseekee Indian Reservation, which is located in the Everglades, flooding buildings and drowning hundreds of deer. In 1990, outflows drowned 90 percent of the entire deer population in the Everglades. Entire forests of bald cypress trees have died (Dugan 1993).

Wood storks once nested in colonies of 10,000 or more in the swamps northwest of the national park in the Corkscrew Swamp Sanctuary (Toops 1989). This 10,560-acre National Audubon Society sanctuary now protects 400 or fewer pairs of these birds; storks require shallow, freshwater pools that concentrate fish, especially during nesting season, to feed their young. Because of the drainage of the agricultural area and the lowering of water levels, wood storks died out and their chicks starved in the nest (Toops 1989). During the 1930s, at least 75,000 wood storks bred in Florida, but by 1975 there were only 12,000 (Kale 1978). They continued to decline, and in 1980, only 5,000 pairs remained (Lucas 1996). In 1984, the US Fish and Wildlife Service added the US population of wood storks to the Endangered Species Act.

The loss of water in the Everglades has had dramatic effects on alligators. They grow at abnormally slow rates, are underweight for their age and more anemic than alligators in other parts of the South. Research on the diet of these reptiles in 1997 revealed they were malnourished. The once-abundant populations of fish have disappeared, and alligators are forced to scavenge carcasses and feed on small mammals and snakes.

Federal protection was accorded to the southernmost 1.5 million acres of the Everglades by establishment of the Everglades National Park, but its ancient water flow pattern has been so disrupted by channeling, diversion and drainage that the ecosystem is a shadow of its former self. Adjoining the park to the northwest is Big Cypress National Preserve, an area of 570,000 acres also under the jurisdiction of the National Park Service, but with less restrictions; hunting, fishing and even mining are allowed in National Preserves under certain circumstances.

After 50 years of declining wildlife and proposals to restore the Everglades, Congress passed the Everglades Forever Act of 1994 (Cushman 1996a). Forty miles of the Kissimmee River, whose huge oxbows and curves through marshy pineland were turned into a diked canal by the US Army Corps of Engineers, will be returned to natural bends by this same agency. The cost of repairing the damage is an estimated $500 million, 14 times what it cost to obliterate the river's original curves (Levin 1996). Diking and channeling shortened the river from 103 miles to 56 miles, and a wet prairie where a million ducks wintered was drained (Levin 1996). A recent survey of the area found a total of eight ducks, and droughts in the region have increased (Levin 1996). Some local ranchers oppose the plan, but it has received the support of conservationists and, after intense lobbying, of President Bill Clinton. The nearby National Audubon Society's Kissimmee Prairie Preserve nearby, protects 8,000 acres of the original 30,000-square-mile flood plain of this river (Levin 1996).

Under the 1994 Everglades Forever Act, 40,000 acres of the agricultural lands will also be restored to marsh. A 3-mile-wide flow-way from Lake Okeechobee into the Everglades is another facet of the restoration plan. This would revive marshes below the lake. Sugar farmers have protested government acquisition and resent the proposed controls on the amounts of fertilizers and pesticides that can be released into the water system. The sugar industry in Florida receives $1.4 billion per year in federal tax breaks, and it has balked at any loss in its economic status. Added to the loss of acreage, the industry was angered by a proposed "sugar tax" that would have raised $245 million over a seven years to restore the Everglades (Levin 1996). Political contributions of more than $15 million from the sugar industry to presidential and other politicians™ campaigns to represent their case have stymied efforts to restore this

internationally important wetland. The funding was dealt a severe blow in November 1996 when Florida voters rejected the sugar tax plan on the Presidential ballot.

Funding by the Congress, which voted $7.8 billion for the Everglades Restoration Fund in 2000, permitted the project to go forward (Schmitt 2000). Florida will pay half of this sum over the next 40 years to redirect 80 percent of water now diverted back to the Everglades through an untested system of quarries and aquifers, and by removal of dikes and barriers (Schmitt 2000). The plan may not succeed in its goal of restoring the original ecosystem, but water flow will be improved, allowing wildlife to recover some of their populations. In another positive decision, plans that called for turning Homestead Air Force Base at the edge of the Everglades near Miami into an international commercial airport with hotels, development and new roads were canceled in early 2001 by the Clinton Administration (Canedy 2001).

Cleaning up Florida Bay and returning the sea grass to dead areas is another project that began in the 1990s, but it lacks the funding of the Everglades restoration. Its western portion is now saturated with algae, and the native turtle grass has disappeared from large areas (Stevens 1997). The tourist industry centered on snorkeling and diving is in decline as a result. A lack of fresh water has caused increased salinity and a resultant influx of water laden with agricultural chemicals. This aggravates the growth of algal blooms, such as red tide. Endangered sea turtles inhabit Florida Bay, and the coral reefs are home to a great diversity of fish and invertebrates, all of which are in steep decline.

The tourist industry brings $13 billion to Florida each year, a large percentage from Everglades tourists and others who come to appreciate the coral reefs and wildlife. This should impact decisions made to save the Everglades National Park, surrounding wetlands and Florida Bay.

The restoration of the Everglades represents an about-face for the historical approach to wetlands in the United States, and it may be copied in other parts of the country. Wetlands legislation still includes certain concepts such as "mitigation," a legal loophole allowing destruction of one marsh or wetland if another is preserved or created. Many ecologists consider that the natural wetland is far more complex and irreplaceable than the man-made one, and they should not be considered equal under the law (Daily 1997, Williams 1996). These man-made wetlands often fail to function naturally, and the concept of allowing such wetlands to be constructed when natural wetlands are destroyed is flawed. Developers often construct new wetlands in unnatural blocks without proper natural hydrology or native plants and animals.

Non-governmental organizations, such as The Nature Conservancy and the International Crane Foundation (ICF), have played a significant role in preserving many threatened wetland habitats for birds. The demilitarized zone between North and South Korea is a major refuge for cranes, white-tailed sea eagles and other water birds. Rare white-nape cranes (*Grus vipio*) were discovered feeding in the Han River estuary just south of the zone prior to the diking of these marshes for rice production. Dr. George Archibald, co-founder of ICF, and Korean ornithologist Kim Hon Kyu, convinced the South Korean government to set aside this marsh. Other key wildlife wetlands under threat have been preserved through the diplomacy of these conservation organizations and cooperation between biologists and governments that have bridged old enmities.

The problem of sewage and runoff from roadways, agricultural fields and suburban housing areas will only grow in the future. A US government project to deal with this problem has used natural solutions that could be imitated elsewhere. The project constructed shallow basins to capture runoff that then flows through grass, which removes solids and nutrients, and then to a cattail marsh for further cleansing. The last step is a deep pond with fish and mussels, which filter the water. Ten of these systems have been installed in Maine at a very small cost of $14,000 to $35,000, and similar structures have been built in New Jersey, New York and Massachusetts (Williams 1996). A new treatment process, vermifiltration, in which earthworms in soil filters extract nutrients and suspended matter from sewage, produces an effluent free of pathogens and ideal for irrigation. Several towns and cities in California have created marshes to filter sewage that has been given secondary treatment. These have become wildlife havens and

even tourist attractions. By contrast, Boston constructed a 9-mile pipe to carry treated sewage into Cape Cod Bay, where over 300 million gallons will be dumped each day, posing a threat to fisheries and other wildlife. Its cost was $390 million. Some cities have tapped sewage for methane gas to power city facilities.

Scientists are now attempting to address th**e** problem of soil salinization with salt-resistant plants. Department of Agriculture research has also found river reeds that turn toxic chemical runoff into water and carbon dioxide, poplar trees that absorb pollutants from groundwater, and grains and grasses that absorb fertilizer and herbicides, breaking down the toxins (Howe 1997). Prevention and care to avoid such pollution before it happens is even more important for the future.

The facilities for the 2000 Olympic Games at Sydney were designed to be environmentally sensitive. Recycled storm water was used for toilet flushing, and sewage effluent was filtered and recycled (Zuckoff 2000a). A degraded creek was restored to its former state, and when the rare Bell frog (*Litoria aurea*), was discovered on the site of the tennis center, special tunnels were built to allow these frogs to move through it unharmed (Zuckoff 2000a). This center did not create oily residue from automobiles on asphalt parking lots because these were the first Olympic Games to ban all internal combustion cars, requiring travel by trains that connected facilities and solar cars built for the games (Zuckoff 2000a).

Conservationists in the future will need to overcome the effects of a global economy spurred by corporate profits and politicians pushing destructive water projects through legislatures, only to repay financial contributions made to their campaigns or political favors done for them. Extraordinary wildlife habitats can be destroyed with the stroke of a pen. The Copper River Delta of Alaska is a large wetland vital to millions of waterfowl, shore birds and marine mammals, but politicians have proposed construction of a road through it for the benefit of loggers who want to remove timber.

With the warming of the global climate, ship traffic through the Arctic Ocean will increase, and the vast river deltas and waterfowl habitat in northern Canada will soon be threatened by oil tankers and construction of gas pipelines and roads. This region is vital habitat for a large percentage of the continent's waterfowl and shore birds, polar bears (*Ursus maritimus*), whales, seals, walrus and fish. Diamond mining and other development are already encroaching on this pristine area.

The extent of our interference with natural ecosystems is undoubtedly adversely affecting evolution. Nature has evolved superb adaptations in aquatic species**,** survivors for millennia within their habitats. We are just beginning to appreciate and understand the great diversity in aquatic ecosystems and the awe-inspiring beauty here. It is vital that this new understanding be used to protect, not destroy.

Rivers: Dams, Canals and Channeling

More than half of all accessible water is diverted for use by humans (Barlow 1999). Large-scale dam projects on major rivers have increased worldwide from 5,000 in 1950 to 38,000 by the end of the 20th century (Barlow 1999). More than 100 major dam projects are planned in West Africa alone, and conservationists predict crashes in fisheries and flood plain crops as a result (Dugan 1993). Many giant dams have ruined wilderness areas in order to produce electricity for which no demand existed. Wild and beautiful rivers in Indonesia, Brazil, India, Zambia and elsewhere have become fetid lakes, with an enormous loss in wildlife and plants. Many of the tributaries of the Amazon, the world's largest river and home to the greatest diversity of freshwater fish in the world, have been dammed over the past 50 years. In the process, hundreds of species of plants became extinct, drowned by the dam's rising waters.

Page 1 (Dams: Profit and Loss)

Page 2 (North America)
Page 3 (Asia)
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Between 1973 and 1983, Brazil borrowed $30 billion Brazil from international funds, such as the World Bank, to construct these dams (Lanz 1995). Huge debts are incurred by poor countries borrowing money from international funds to pay for dams. The real profits from dams accrue to companies that construct them and industries that directly benefit (Lanz 1995). Yet the rationale for dams has traditionally been to benefit the population as a whole. Numerous extinctions of native wildlife and plants have resulted from dam construction. This makes the real cost of such cheap electricity far more expensive, yet such calculations are not considered when nations endorse dams.

Until the 20th century, all but a few of the world's major rivers were pure. Today, the opposite is true. Unpolluted, un-dammed rivers are the exception, and even the great diversity of the mighty Amazon River is now threatened by dam construction on its tributaries. These dams have endangered countless species of wildlife. The majority of species evolved to live in rivers are unable to adapt to conditions created by artificial barriers such as dams and resultant changes in water temperature and current. In the United States, only 2 percent of rivers remain free-flowing and undeveloped (Barlow 1999). All major European rivers have been dammed, diked or channeled. After dam construction, reservoirs, which often cover hundreds of square miles, gradually fill, drowning untold thousands of animals in the process. Even those able to swim to dry land rarely survive because territories are already occupied by members of their own species. In tropical forests, threatened monkeys, armadillos, rodents, snakes and other animals drown, and rare plants and trees die under hundreds of feet of water. Dam gates cause wildlife mortality as well. Endangered West African manatees (*Trichechus senegalensis*) have been crushed to death when caught in the giant gates of these dams, or left high and dry when water levels were lowered (Reynolds and Odell 1991).

Dams upriver from coastal marshes disrupt the flow of water, which can cause crashes in breeding fish populations. Dammed rivers that empty into coastal deltas experience reduced freshwater flow, which creates an influx of saltwater into freshwater marshes (Lanz 1995). This devastates fisheries adapted to low salinity, such as many species of shrimp and crayfish. An extreme case is in Louisiana; its entire marsh coastline and its $700 million-per-year fishery-based economy have collapsed over the past few decades as saltwater has crept into freshwater marshes, drowning 1 million acres a year. Dikes and levees built for shipping traffic on the Mississippi River and its tributaries have decreased the freshwater flow into the marshes, causing this disaster. Another negative effect of dams on coastal ecosystems is the blockage of silt and sand that enriches delta marshes and maintains sandy beaches. Dams generally have to be abandoned within about 50 years because they fill up with silt and can no longer function efficiently. The serious environmental damage caused far outweighs these short-term economic benefits.

Migratory fish, from salmon to sturgeon and shad, find their paths blocked by dams. They leap in vain at the concrete barriers, and most fail to negotiate fish ladders on those dams that have installed these devices. The young of salmon that manage to hatch upstream from dams are crushed and torn to bits in the dams' massive turbines, which kill 90 percent of salmon young each year in the Pacific Northwest of the United States. Virtually every species of the seven salmon native to this region is threatened with extinction, and 214 stocks are threatened; 106 populations have already disappeared (Stein *et al*. 2000). These salmon and steelhead trout have also suffered from siltation caused by logging and agriculture, which has clouded the clear streams needed for spawning. The loss of these salmon, which numbered in the billions when Lewis and Clark entered the region in the early 19th century, has affected the livelihoods of hundreds of fishermen and wildlife that depended on these fish. Bald eagles, black and grizzly bears, river otters and many bird species rely on these fish as a vital food resource. Each fall, bears eat large quantities of fish, especially fatty fish like salmon, to fatten up prior to their winter hibernations. Without these fatty stores, many

bears do not survive the winter.

The outflow from dams is regulated by opening of gates, resulting in flows ranging from trickles to torrents. Wildlife requiring a certain water level can be eliminated when it changes radically. Rare trumpeter swans (*Cygnus buccinator*) wintering in eastern Idaho died in large numbers in 1989 when the reservoir on the Henry's Fork tributary of the Snake River was closed during a drought. The water downstream had previously remained unfrozen in winter, providing vital habitat. In February 1989 when the water froze as much as 4 feet below the surface, more than 50 swans froze or starved. The surrounding community became so concerned they raised $30,000 to purchase 4 billion gallons of reservoir water to be released. *Life* magazine photographer Glenn Oakley documented locals picking up and carrying the surviving swans to indoor areas; some were even warmed in nearby bathtubs. These swans were then transferred to a rehabilitation center where they were kept throughout the rest of the winter, and grain was supplied to the weakened swans remaining in the wild (Life April, 1989). In the words of a rescue coordinator from the Idaho Department of Fish and Game, "I guess nobody ever told these swans they should have filed for water rights."

Even more tragic events took place in Canada, where a massive dam project has inundated some 4,000 square miles of forest land and riverine habitat in Quebec and Labrador. These dams have had major effects on both people and wildlife since the 1970s. They impeded the ancestral migration route of caribou and caused 10,000 of these animals to drown in a torrent of water from one of the new dams in 1990 (Verhovek 1992). Chief Matthew Coon-Come of the Grand Council of the Crees appealed to conservationists to assist tribes in stopping any further work on the dam system. "For 5,000 years we did not leave a trace of our having been in James Bay. What we had came from the land and went back to the land. The land is sacred to us. This land holds the graves of our ancestors. But now, Hydro-Quebec is destroying our sacred land and our way of life. If you were to fly with me today in a Cessna, starting from the first James Bay dam, we'd fly for four and a half hours, and all you'd see is land drowned by water, three major rivers destroyed" (Coon-Come 1993). Chief Coon-Come first began fighting the dam projects in 1972 when he was 16 years old, and in 1994, at the age of 38, he was honored as the first North American recipient of a Goldman Environmental for his achievements in stopping the second phase of the James Bay project.

The Indus River dolphin or Susu (*Platanista minor*) of Pakistan and the Ganges dolphin, which also inhabits the Brahmaputra River system, are highly endangered. These dolphins appear to be blind, but have deeply set eyes that can receive light at an angle, perhaps when they surface (Nowak 1999). Of the two, the Indus River species is more endangered and considered to be on the brink of extinction (Leatherwood and Reeves 1983). It is considered endangered. This dolphin's entire range lies within the Pakistani provinces of Sind and Punjab where, despite of legal protection, it has declined, mainly as a result of a series of dams on the Indus that isolate populations, along with accidental drowning in fish nets and pollution (NGS 1995). Its population has been estimated at only about 400 animals between two dams in the Sind Province, and perhaps 150 more in small subpopulations farther north in the Punjab Province (Nowak 1999). The Ganges River dolphin inhabits a larger range and is found in western India, Bangladesh and Nepal. Pollution, boat traffic, fragmentation of populations by dams, accidental capture in fishing gear and hunting all threaten this species (Nowak 1999). 4,000 to 5,000 Ganges dolphins survive, and the species has disappeared from the Karnaphuli River to the east of the Ganges at the very least (Nowak 1999). In Nepal, dams have blocked portions of the dolphins™ range, trapping them in portions of river too small to ensure their survival (Leatherwood and Reeves 1983).

Fish and mollusks are especially vulnerable to disappearance when their habitats are radically changed by dams. The conditions created in the reservoir usually end in the destruction of aquatic vegetation, bottom-dwelling mollusk fauna, and the fish, turtles, birds and mammals that are part of free-flowing rivers. Sediment soon covers the mollusks and bottom vegetation and kills them, and water currents no longer bring food to the gills of mollusks and keep water clear. Caddis and stone flies, upon which trout and other fish feed, disappear when their larvae do not hatch in reservoir conditions (Lanz 1995). These insects are the primary food for trout and many other fish. Cold temperatures of swift-flowing, tree-lined rivers in temperate areas that teem with trout and salmon become warm, pond-like areas, to which these species cannot adapt.

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With a total of 297 species, North America has the world's greatest diversity of freshwater mussels, though they have suffered dramatic declines as a result of dams (Neves 1996). Free-flowing rivers and streams have been turned to ponds, and to compound the damage, the dam builders usually channel rivers downstream. Using machines with revolving chopping blades, natural, curving rivers and streams are converted into straight ditches. Stream edges are cleared of vegetation, and river bottoms are dredged, depositing mollusks and crustaceans in piles along the banks. What is left is a sea of mud in a ditch devoid of life. Malacologist Dr. George M. Davis (1977) concludes these projects, combined with acid drainage from strip mining, erosion and pesticide runoff from agriculture, have been the major causes for the near-extinction of much of the continent's native mollusk fauna (Davis 1977). At least 102 species are considered threatened in the United States, 97 percent of these from habitat loss or degradation (Stein *et al*. 2000).

Prior to the devastation of their habitats, mussels clustered in vast numbers on river bottoms throughout the major rivers and their tributaries in the Midwest and southeastern United States. These rivers meandered through forests that provided cool shade. River otters, muskrats and mink denned among tangled tree roots and in banksides. Water quality remained clear as a result of the forests and the filtering actions of the mussels. River snails fed on the detritus and algae of the mussel shoal, further cleansing the water. The mussel shells formed large, reef-like piles on river bottoms, providing habitat for fish, crayfish, water plants and large river snails. Turtles, aquatic birds and mammals fed on the fish, mussels, snails and crayfish in this ecosystem.

A major center of diversity for these mussels is Alabama, which has more than 235,000 miles of waterways and three major river basins left untouched by Pleistocene glaciers, preserving a great diversity of species (Stein and Flack 1997). Having survived the Ice Age, many species of mussels, fish and crayfish became extinct or endangered when water projects began destroying their habitats in the 1920s. The richest of all known beds, Mussel Shoals, located in the Tennessee River of Alabama, once had a diversity of approximately 70 mussel species. The Wilson Dam, completed in 1924, submerged Mussel Shoals and covered them with 15 to 20 feet of mud, causing the extinction of at least half the mussel species and five of the seven large river snails (Davis 1977). Experts at the University of Alabama in Tuscaloosa report 69 percent of mussel species are extinct, endangered, threatened or of special concern in the rivers and streams of the state (Cushman 1995b).

Many mussel species need small fish to complete their reproductive cycles. One threatened mollusk, the orange-nacre mucket (*Lampsilis perovalis*) of the Mobile River basin, produces larvae that resemble tiny fish; they anchor to the adult mussel with a long, wavy mucous strand that acts as a lure to tiny fish; when a fish attempts to eat this larva, however, it breaks away and attaches to the fish's body (Hartfield and Butler 1996). The fish carries the mussel larvae to a new area. Other mussels have different reproductive strategies. In some cases, fish congregating around the beds are parasitized by embryonic mussels who cling to their fins or gills and become enclosed in a cyst. The larvae absorb nutrients from the fish for two or three weeks, growing into juvenile mussels, and in the process, they are transported to new areas, where they detach and colonize stream beds (Hartfield and Butler 1996).

The orange-nacre mucket is one of many species that have disappeared from most major rivers, and only small streams and creeks now afford suitable habitats for the creature (Hartfield and Butler 1996). The host species for many mussels are darters. These fish exhibit a rainbow of iridescent hues in a multitude of patterns. Many of their names are evocative of their color or origin: Amber (*Percina antesella*), Bayou (*Etheostoma rubrum*), Goldline (*Percina aurolineata*), Slackwater (*Etheostoma boschungi*), Watercress (*Etheostoma nuchale*) and Okaloosa Darters (*Etheostoma okaloosae*). All the latter species are listed on the Endangered Species Act.

The most famous of these little fish is the 3-inch snail darter (Percina tanasi). Named after the river snails upon which it feeds, this species was discovered on the Little Tennessee River in 1973 above the Tellico Dam site after construction of this major dam by the Tennessee Valley Authority (TVA) had begun. Construction continued after the TVA was able to reverse preliminary injunctions to delay the dam brought by conservationists and irate Tennessee residents being evicted from their land. By the time the snail darter was scientifically described, proposed and listed under the Endangered Species Act, the dam was nearly complete. There is evidence that construction was hastened when word of the fish's discovery became known, in order to prevent conservationists from stopping the dam. The snail darter's survival is due to transplants into other parts of the Little Tennessee River and a few of its tributaries and its discovery in 1980 on a new site in Tennessee™s South Chickamauga Creek, by Dr. David Etnier of the University of Tennessee, who originally discovered the species. The snail darter is now known to exist in Alabama and Georgia, as well as Tennessee. It has been reclassified as threatened under the Endangered Species Act. It does not owe its existence to the TVA, however, which destroyed its only known habitat with a dam, nor to Congress, which rewrote the Endangered Species Act to sanction the extinction of this and other species that might impede "development."

Over three hundred types of crayfish are found in the United States; these species make up 61 percent of the 525 crayfish species found worldwide (Stein *et al*. 2000). Most species live in rivers, streams and waterways in the southeast (Clancy 1997). These crustaceans share many of the same ecosystems inhabited by mussels, darters and snails, and about half the species are threatened with extinction (Stein and Flack 1997). Hiding in crevices, under rocks and buried in sand, crayfish attempt to escape herons, raccoons, river otters and predatory fish (Clancy 1997). A 1996 study by the American Fisheries Society found 65 species of crayfish living in a single river drainage (Clancy 1997). They are usually only 3 or 4 inches long, and like lobsters and shrimp, females carry fertilized eggs attached to the underside of their abdomen. Even after hatching, she allows them to cling to her abdomen for several weeks before they become independent (Clancy 1997).

Native crayfish have declined along with mussels and fish in the altered environments created by dams and channeling. Only four crayfish species out of more than 150 species considered imperiled by The Nature Conservancy are listed on the Endangered Species Act, and almost nothing has been done for their preservation (Clancy 1997). The Nature Conservancy has programs to educate people to protect the land around streams from pollution from cattle, and it is building partnerships with local, rural organizations and conservation groups. The goal of their programs is to preserve the habitats of native crayfish and hundreds of other species by arresting water pollution and other misuses of waterways. This benefits the local economies in the process.

Mussels, crayfish and darters are important indicators of environmental quality because of their great sensitivity to changes in water quality. Scientists have warned a mass extinction of American mussels and crayfish is imminent. Public interest is sparse for these endangered species, lacking the popularity of the bald eagle, the gray wolf or even the black-footed ferret. Yet they are critical to the healthy functioning of southeastern aquatic ecosystems and represent a precious source of diversity on the continent.

The damming of southern rivers continued in the 1960s and 1970s. By 1967, there were nine dams on the Tennessee River, leaving only 22 miles free-flowing. The last un-dammed river in Tennessee, the Duck River, was dammed in 1975. It contained the greatest diversity of snail species left in the Tennessee-Ohio River system (Davis 1977). The Fish and Wildlife Service listed seven species of endangered mollusks native to the Duck River on the Endangered Species Act when the Columbia Dam was under construction. In retaliation, the TVA brought an unsuccessful lawsuit against the Department of the Interior (FWS 1979). Besides the biological impoverishment resulting from destruction of natural rivers and streams, many potential food sources for humans are lost, such as mussels, crayfish and fish.

For fish of rivers in the US West, the opposite conditions prevailed. Flowing through desert landscapes, these rivers tend to be warm and turbid from eroded soil. The Colorado River evolved an extremely rich, endemic fish diversity adapted to this water type. During the 20th century it was dammed throughout its course. Dam operators of the 49 dams on this river occasionally release water from these reservoirs. Coming from the bottom of the reserves,

the icy, cold water inundates ecosystems below, creating habitats that endanger native fish. Among these endangered fish are the humpback chub (*Gila cypha*), the Colorado squawfish (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*). The Colorado squawfish, a large fish reaching 6 feet, was once an important food fish for natives and settlers. None of these species have been able to adjust to the cold, clear waters of the dammed Colorado River, which prevented their free movement. The Fish and Wildlife Service has artificially maintained these and other endangered fish in hatcheries, and some populations survive in un-dammed tributaries. Dams on the Colorado River have also inundated precious riverside habitats of small marshes where rare water birds bred. The delta of the Colorado River was once a vast marsh in northern Mexico, a wildlife haven which harbored millions of waterfowl and fish. It was the life blood of the Cocopa tribe. As a result of the dams and diversion of its water to Los Angeles and for local agriculture, the delta is now a mere trickle. The silt that was once deposited on banks and in the delta is now retained upstream, depriving ecosystems downstream of nutrients.

Although the rate at which natural rivers are being dammed has slowed considerably in recent years, for many species the damage has been done. A growing number of organizations and individuals have been urging the removal of dams, especially those causing extinctions. The McPherri Dam on a tributary of the Sacramento River, which once had one of the largest salmon runs in the state, was demolished in 1998, and a few days later, another dam in Medford, Ore., was breached (Egan 1998). A dam on Maine's Kennebec River was removed in 1999, allowing salmon and other fish to return to former haunts. This required the work of many conservationists for more than a decade, and many politicians and others in the state opposed its removal. The 75,000 US dams were often built at huge public expense. Congressional representatives have pushed these projects through Congress for decades, promoted without real analysis of need, economic benefit or environmental effect. Some of the larger dams may be more difficult to remove. The dams on the lower Snake River in the Northwest, for example, have eliminated the millions of salmon that once spawned here, affecting wildlife and local economies. A major effort to breach these dams to allow passage of salmon is gaining momentum, but many barge operators and farmers who transport their grain to market on the barges are strongly opposing the breaching of these dams. In the future, dams may be regarded with less respect as naturally flowing rivers become better appreciated. As former Secretary of the Interior Bruce Babbitt said while commencing the destruction of a dam: "Dams are not like the pyramids of Egypt that stand for eternity. They are instruments that should be judged by the health of the rivers to which they belong" (Egan 1998). Breaching is a compromise to removal of dams that may be more acceptable to dam defenders.

Rivers: Dams, Canals and Channeling: Page 3

The Aral Sea, 300 miles to the east of Siberia's Lake Baikal, is ancient in origin. This was once the fourth-largest lake in the world, covering 25,000 square miles (Kinzer 1997). Two giant dams were constructed in the 1960s on its two feeder tributaries, the Amu Darya and Syr Darya. The diverted water was sent to the south to produce cotton (Filipov 1997). This crop requires great amounts of water and is unsuitable for the arid steppe region. The loss of its feeder rivers caused the Aral to shrink over the next 30 years from 25,675 square miles to 14,090 square miles, and its shores receded up to 50 miles (Stewart 1992). By 1997, it covered only 12,000 square miles, and it continues to shrink (Kinzer 1997). This once rich lake in the midst of the dry plains of Central Asia is expected to completely dry up by 2010 (Filipov 1997). As it dried up, the sediment from the Aral Sea's bed, which contained toxic chemicals, blew away, coating everything within hundreds of miles with 150 million tons of contaminated dust (Filipov 1997).

The wealth of diversity that once teemed in this desert sea has been lost. The destruction of this beautiful lake and its wildlife is without parallel anywhere in the world in recent history, an environmental catastrophe. The water that remains has become increasingly saline and polluted by unregulated industries (Filipov 1997). The collapse of the fishing industry has caused great financial hardship to the people who had lived along the shores of the Aral for centuries. In the 1950s, the Aral produced 40 to 50 tons yearly of sturgeon, pike and roach, among other species of fish; all of its 24 endemic fish are now extinct (Stewart 1992). The mayor of the town of Muynak, located at the

southern end of the lake, recalled, "Our fishing boats used to bring in 30,000 tons of fish each year." The town's population dropped from 45,000 in 1967 to 28,000 in the late 1990s (Kinzer 1997).

Of the Aral Sea region's 173 animal species, only 38 survived until the early 1990s (Stewart 1992). Almost all birds disappeared, along with the last of the fish, and only brackish pools remain along the shoreline (Filipov 1997). In March 1991, the Aral Sea was officially declared an ecological disaster area, and the Soviet government appealed to the United Nations Environmental Programme for help; an inter-republic commission was set up to reduce pollution, but with the dissolution of the USSR., the project was abandoned. In the years since the Soviet Union dissolved, destruction has continued unabated (Filipov 1997).

The five newly established Central Asian nations of the region, Kazakhstan, Uzbekistan, Krygyzstan, Tajikistan and Turkmenistan, are now competing for control of the water from its two feeder rivers to maintain their irrigation-fed agriculture (Filipov 1997). Although the leadership of these countries agree urgent action is required to save the Aral Sea, they are not ready to take drastic measures to conserve water (Kinzer 1997). Ironically, much of the diverted water is lost to evaporation and seepage because the irrigation canals were neither covered nor lined (Kinzer 1997). What water is left after heavy application of pesticides and other chemicals sprayed on cotton and rice fields becomes poisoned and trickles into the Aral, further contaminating it (Kinzer 1997). Cancers and other illnesses have struck the local people in Muynak (Kinzer 1997). An environmental organization, Aral-S-O-S, is attempting to reach agreements among the countries, but admits the countries' philosophy of considering water their national property may make the goal unattainable (Kinzer 1997). These nations continued discussions in 2000 without taking any action to prevent the impending loss of the Aral Sea.

In the majority of cases, dams are constructed with little or no knowledge of the ecosystems they are ruining. Likewise, the governments that authorize the dams rarely consider environmentally sound alternatives. In the 1940s, the Volga and Kama Rivers, 300 kilometers north of Moscow, were dammed to form an enormous reservoir that flooded 455,000 hectares (1,124,305 acres) of arable meadowland to produce a relatively small amount of electricity (Lanz 1995). Dams on the Volga impeded the natural migration of sturgeon from the Caspian Sea for their spawning, resulting in a catastrophic decline in the world's most valuable fish. Beluga caviar from the beluga sturgeon (Huso huso), an endangered species, is the most valuable fisheries product in the world, made more valuable by its continued decline in the Caspian. All the Caspian's species of sturgeon are endangered, as are species of the Amu-Dar and Syr-Dar Rivers feeding the Aral Sea.

The Three Gorges, a Yangtze River Dam project in China that will be completed in the next five years, will be the world's largest hydro-electric project. This dam, expected to cost up to $120 billion, will be 607 feet high, span over a mile and flood 400 miles of this major river, including 30 million acres of cultivated land (Carpenter 2001). The portion of the Yangtze River to be dammed is one of the most picturesque landscapes on Earth, its swift waters flowing through steep gorges and mountains enshrouded in mist. It has been painted by Chinese artists for centuries. The three gorges that will end up under water, the Qutang, Wu and Xiling Gorges, have tributaries and feeder streams that will also be adversely affected. One of these, north of the town of Wushan, the Daning River, is home to many ancient species of trees, such as the Dawn redwood (*Metasequoia glyptostroboides*), the dove tree (*Davidia involucrata*) and various ginkgoes (Hoh 1996). Forty-seven species of rare or endangered plants listed by the Chinese Academy of Science will be inundated when the dam waters rise; among these are many endemic medicinal plants (Hoh 1996). Funds are lacking to treat the 265 billion gallons a year of raw sewage and industrial waste that will flow into the impounded waters from the Three Gorges Dam (Tyler 1996). The project's managers admit there are no immediate solutions to the sewage and pollution problem, or to the impact of huge volumes of sediment that could clog the entire flow of the river (Tyler 1996).

The Yangtze River dolphin (*Lipotes vexillifer*) inhabits this part of the river and faces imminent extinction. Restricted to the Yangtze and portions of the Quiantang River, it has disappeared from much of its original range (Nowak 1999). This dolphin evolved in swift, muddy waters, preferring to live near large eddies. The sonar in its bulbous head is able to locate fish without vision. While this species is actually almost blind, these dolphins have

tremendous physical strength to negotiate strong currents. Boat travelers in the river 50 years ago saw hundreds of these dolphins leaping and swimming throughout its length, along with birds and other wildlife. Today, almost no wildlife can be seen. This species was endangered by other dams, collision with boats and ships, dynamiting for channel maintenance, pollution, accidental drowning in fishing nets and loss of food to over-fishing by humans, even prior to the Three Gorges dam construction (Nowak 1999). A large male found dead in January 1996 was examined by scientists; they determined he had died from an electric shock device used to kill fish in the Yangtze River (CNN 1996).

The lakes along the Yangtze once sheltered hundreds of dolphins, but sedimentation from agricultural runoff covered the lake bottom, and sewage polluted the water. It has disappeared from almost all its former strongholds. Surveys in 1986 found 300 animals, but in 1993, 200 or less were estimated to remain, and more recently only 9 individuals could be found (Nowak 1999). This species, adapted for millions of years to life in these rivers is now considered the most endangered of all cetaceans (Nowak 1999). The upper Yangtze will soon be awash in sewage and other pollution from the Three Gorges Dam, which will also block its movements, a habitat where these last dolphins are unlikely to survive. The sole native dolphin in captivity, Chichi, a male, has lived in a small concrete tank at the Institute of Hydrobiology in Wuhan since 1980 when fishermen snagged him on their hooks; he still has scars from these wounds. Pneumonia killed one young female placed with him, and several other females put in his tank in the hopes of captive breeding have died as well, according to a 1999 PBS documentary, "Great Wall Across the Yangtze."

Ocean Park Conservation Foundation in Hong Kong, in cooperation with the IUCN Cetacean Specialist Group and the Institute of Hydrobiology in Wuhan, China, have cooperated in a project to capture as many of the remaining animals as possible before the dam fills and move them to the Shishou Seminatural Reserve (Leatherwood and Genthe 1995). The reserve, a natural oxbow in the Yangtze, also harbors ten finless porpoises (*Neophocaena phocaenoides*) Œ a species that has lived in the river with the dolphins for thousands of years. Finless porpoises are also native to coastal waters west to Saudi Arabia, but their status is not well known. This solution is unlikely to protect more than a few members of the species, and it will almost certainly fade into extinction in the near future. Another species unlikely to survive the effects of this dam is the endemic, migratory Yangtze sturgeon (*Acipenser dabryanus*).

The dam will also affect the Yancheng Marshes, covering some 938 square miles on the north-central coast. Extending for 186 miles, they form a floodplain for the Yangtze River (Simon 1995). Over half a million water birds and shore birds winter here, including the highly endangered red-crowned crane (*Grus japonensis*), whose population in this wetland increased from 200 in 1981 to over 600 in 1987 (Simon 1995). The tidal flats of the Yangcheng are being reclaimed for agriculture, presenting another threat to this species, whose world population totals only about 2,200 birds (BI 2000). Another rare bird, Saunder's gull (*Larus saundersi*), has a world population of only 7,000 birds in decline (BI 2000), breeds in the Yancheng (Simon 1995). This marsh is of great importance to the 226 birds recorded here, since the vast majority of wetlands in China have been drained, polluted or are heavily hunted (Collar *et al*. 1994). For Pere David's deer (*Elaphurus davidianus*), the Yangcheng Marshes are a new home, one of several reintroduction sites for this species that became extinct in the wild and was rescued by captive breeding in England (Simon 1995).

Another water project, said to begin in two years, will divert water from just west of the Yangtze north to Tianjin, a city southeast of Beijing that is suffering water shortages (Eckholm 2000). Should this be carried out, the combined effect of this diversion and the Three Gorges Dam will decrease the flow of the Yangtze River so greatly that these marshes may dry up. Water from the Yangtze River west of the Three Gorges Dam will also be diverted north to the Yellow River, which has been overused and sometimes runs dry, and to mountain zones in the northwest and south (Eckholm 2000). Canals and reservoirs will be dug to carry this water in projects that will cost more than $12 billion (Eckholm 2000). The effects of these diversions on the remaining wildlife of this river will be devastating.

Rivers: Dams, Canals and Channeling: Page 4

Africa's rivers have also been dammed, eliminating wildlife. Most recently, a dam on Tanzania's Lower Kihansi River, costing $272 million, has blocked the flow of a beautiful waterfall, the sole habitat of a newly discovered toad, the Kinhansi spray toad (*Asperginus nectophrynoides*) (Donnelly 2001). This tiny, translucent toad is confined to a 10-acre marsh sprayed by the waterfall. The major source of funds, World Bank, was informed of the imminent extinction of the toad and the loss of the waterfall in 1997, but took no action until Friends of the Earth president Brent Blackwelder wrote the bank's president on the topic of the seriousness of the situation and need for corrective action (Donnelly 2001). An artificial spray system was installed for the toads, and 500 of the estimated 11,000 remaining toads were shipped to the Bronx Zoo and the Detroit Zoo. The toads have proven extremely difficult to maintain in captivity, although breeding did take place at the Bronx Zoo. Tiny, wingless insects must be hand-gathered for these toads, which weigh only two-tenths of a gram, and the majority of the zoo department's staff is occupied in caring for the toads. World Bank employees are considering a $5 million loan to manage the habitat around the Kihansi Gorge to prevent the species from becoming extinct (Donnelly 2001). It is remarkable that the World Bank has been forced to consider the survival of a tiny toad, but unfortunate that the entire ecosystem is being destroyed for electricity production that could have been generated in a less destructive fashion.

The amount of fresh water collected by dams worldwide has increased in the past 40 years by 10,000 cubic kilometers, or 10 trillion tons, an amount equivalent to all the moisture in the Earth's atmosphere (Browne 1996). Much of the water retained in reservoirs is lost to evaporation, especially in arid regions. Geophysicists calculate that dam building will continue until all sources of recoverable water have been exploited, a time that is expected to come in the next century (Browne 1996).

Wetland Drainage

The drainage of wetlands has caused extinctions in some parts of the world. The pink-headed duck (*Rhodonessa caryohphyllacea*), native to northeastern India, northern Myanmar (Burma) and central Nepal, was locally common during the 19th century in grassy wetlands, where it was heavily hunted by British colonials (Collar *et al*. 1994, Fuller 1987). The male had very unusual coloration, with a bright pink head and brownish plumage marked in pink and white spots. The female was a slightly less colorful version of the male. Males and females uttered different calls, having very different trachea: The male had a two-syllable metallic cry and the female a loud quack (Fuller 1987). Reduced by sport and market hunting, much of its habitat was gradually converted to agriculture, causing an apparent extinction (Fuller 1987). Although not seen in the wild since about 1936, this species is still listed by the IUCN as critical and there is some hope that it survives undetected (BI 2000, Collar *et al*. 1994).

At least five species of frogs have been extinguished by wetlands drainage. The Israel painted frog (*Discoglossus nigriventer*) was last seen in 1940 before its sole habitat, Lake Huleh, was drained for agriculture. Three species of frogs that inhabited the marshes and wetlands surrounding Mexico City disappeared after the city expanded and filled in wetlands for housing and industry and used others for dumping grounds. Leopard frogs of the genus *Rana: Rana johni* and *Rana pueblae* became extinct about 1979, and Tialoc's leopard frog (*Rana tlaloci*) was extinguished in 1990, according to D.M. Hillis, who wrote his Ph.D. Dissertation for the University of Kansas on the species.

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Wetland Drainage: Page 1

South America's Pantanal, the world's largest wetland, is a vast network of tree-lined rivers, lakes, marshes, savannahs, palm groves and hillocks in southwestern Brazil, neighboring Paraguay and Bolivia (Simon 1995). Estimates of its size vary widely. Some are apparently based on the entire floodplain, and others on the wetland's size during the dry season. They range from 39,000 square miles (Dugan 1993) to 77,200 square miles, the size of South Dakota (Eckstrom 1996). By any definition, it is an immense region, having one of the most distinctive mosaics of vegetation and richest wildlife diversity in Latin America (Dugan 1993).* It is highly endangered by water diversion and drainage programs.

The Pantanal forms the upper waters of the Paraguay River system and is fed by the Cuiaba, Taquari and Miranda Rivers (Eckstrom 1996). During the rainy season, from December to June, the Pantanal drains the entire center of southern South America, fed by runoff from Bolivian highlands and the sources of the Paraguay River, forming a vast, shallow lake 7 feet deep with islands of vegetation (Eckstrom 1996). Amazonian fauna and flora meet with those of southern Chaco grasslands and pampas, creating a center of diversity: 3,500 plant species, 102 mammal species, 652 bird species, 177 reptile species, 40 amphibian species, at least 264 fish species and 1,132 butterfly species are native (EI 2001, Schemo 1996b). This huge wilderness is of vital importance to a host of animals that have disappeared from other parts of their ranges. They are threatened by the presence of 8 million cattle and the cattle management, which includes introduction of non-native grasses and clearing forest land monkeys and other terrestrial animals require (EI 2001). A new ecotourism industry is gaining ground in the Pantanal, and is bringing in funds to the region at a time when its natural treasures are most at risk (Schemo 1997).

Marsh deer (*Blastocerus dichotomus*) are South America's largest deer. They are superbly adapted to living in marshes and wet savannah. Their long, coarse coats repel water, and broad, webbed hooves prevent them from sinking into soft ground (Nowak 1999). Leaping over high grass, these deer move swiftly in this watery environment, using the hillocks and islands of vegetation to rest and have their young. Marsh deer formerly lived in the marshes along the Rio Parana and Rio Paraguay and perhaps as far north as the Amazon River (Nowak 1999). They are gone from Uruguay and have become very rare in Argentina, Bolivia, Peru and Paraguay (Nowak 1999). The Pantanal provides a last retreat for an estimated 7,000 deer, but even here they are declining (Nowak 1999). The species is listed as endangered in the Endangered Species Act, and as vulnerable on the *2000 IUCN Red List*. The estimated five million cattle who graze in the Pantanal (Eckstrom 1996) compete with these deer for habitat and forage. Moreover, cattle have spread brucellosis, which causes reproductive failure, to the deer (Nowak 1999, Thornback and Jenkins 1982). Cattle ranchers have persecuted these deer, and hunting, especially when these deer become stranded on islands during flooding, is another cause of decline (Nowak 1999, Thornback and Jenkins 1982). Dams and drainage for agriculture in the Parana River Delta on Brazil's coast have destroyed much of the once vast marshes there (Thornback and Jenkins 1982).

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*A film that gives an excellent environmental and wildlife portrait of this wetland, fiPantanal: Prairie of the Great Waters,fl was made in 1986 (see Video, Regional, Latin America). It features many of the endangered species described here, along with views of the Pantanal in rainy and dry seasons. A book by Vic Banks (1991), *The Pantanal: Brazil's Forgotten Wilderness*, from the Sierra Club, also gives an overview.

The vast Pantanal is also the most important habitat for the engaging and highly endangered giant otter (*Pteroneura brasiliensis*), which is extinct in most of Brazil and absent from all the larger tributaries of the Amazon (Simon 1995). Killing for otter pelts has been a major factor their decline, and loss of prime habitat is another cause. Degradation of river banks needed for dens by illegal gold miners and cattle, deforestation that affects the water quality and fish with sedimentation and other changes to this wetland have resulted in declines in Giant Otter populations. These otters live in large family groups of up to 20 individuals and require large, high-quality ranges. They are among the noisiest of otter species, uttering a variety of squeals and screams to communicate with one another in the often murky water. This has attracted hunters, who have killed off families and eliminated the species in entire river systems. These otters depend on help from one another, such as loud warning calls about the presence of their major predator, caiman. Their fur is still valuable, although illegal in virtually every market in South America and elsewhere in the world (Nowak 1999).

South America's largest tropical mammal, the South American Tapir (*Tapirus terrestris*), is also native to the Pantanal. Young tapirs have striking white horizontal stripes and spots, which fade into a solid gray as they grow older. Tapirs find the wetlands and abundant vegetation of the Pantanal to be an ideal habitat, and they can be seen swimming in the ponds and bywaters with only their snouts above the water. Like the other three tapir species, the South American tapir has declined throughout its range from hunting and habitat destruction. The IUCN classifies it as near-threatened, and it is listed on the Endangered Species Act.

The Pantanal shelters the largest jaguar population (*Panthera onca*), a threatened species heavily hunted for its pelt and as a trophy. Even in the Pantanal, it was poached until recently, when anti-poaching programs and the Convention on International Trade in Endangered Species (CITES) ban on the sale of spotted cats destroyed the market for pelts and trophies. In this wilderness, jaguars prey on capybara, the world's largest rodent, various deer species and occasionally, domestic cattle. Once heavily persecuted by cattle ranchers, a growing number of cattle ranchers have opened their ranches to ecotourists and now protect jaguars as a prime attraction (Schemo 1997). If there were fewer cattle in the Pantanal, marsh deer, South American tapir and other large mammals would increase, creating a more balanced ecosystem with the jaguar as major predator. This may happen in the future, as the cattle industry is no longer as profitable as it once was (Schemo 1997).

The greatest concentration of water birds in Latin America resides in the Pantanal (Dugan 1993). The jabiru (*Jabiru mycteria*), a large and rare stork, is numerous here, building its great stick nests apart from other water birds. A colony of wood storks (*Mycteria americana*), a species that is endangered in Florida, may total 20,000 birds in the Pantanal. Egrets, herons and Roseate Spoonbills are abundant. Migrants on their way from southern South America to North America, such as the Arctic Tern (*Sterna paradisaea*), use the Pantanal as an important stopover place (Simon 1995), and three major flyways pass through it (Eckstrom 1996). Snail kites (*Rostrhamus sociabilis*), on the verge of extinction in the Everglades, are abundant here, feeding on the huge apple snails common in the Pantanal. This wetland's palm groves are an important food source and refuge for the largest parrot in the world, the magnificent and endangered blue-violet hyacinth macaw (*Anodorhynchus hyacinthinus*) (Sick 1993).

A zoologically important fish species that has been on Earth for 300 million years is also resident in the Pantanal. The South American lungfish (*Lepidosiren paradoxa*) is a member of a family with only six species remaining, all on other continents. Lungfish can breathe air with their single lung and are thought to be an evolutionary bridge between fish and land animals. At about 32 inches in length, this scaled, eel-like fish breathes at the surface when waters are high, and during the dry season, buries itself in the mud, breathing through a narrow tunnel leading to the surface, or entering a torpor-like state (Dorst 1967). Although not restricted to the Pantanal, this wetland provides ideal habitat for lungfish, and a large population is found here.

The Pantanal is decreasing in size as a result of drainage for agriculture, which has altered the flooding cycle (Dugan 1993). The major threat to this wetland is a 2,000-mile canal for shipping being dredged and channeled from the Paraguay-Parana Rivers, which link below the Pantanal. Five countries, Brazil, Bolivia, Paraguay, Argentina and

Uruguay, border these rivers and support this massive program, known as the Hidrovia Project (Schemo 1996b). The canal is intended to open up new markets for a growing agricultural trade for soybeans and sugar, as well as mining products from western Brazil (Brooke 1995). It will extend from Caceres, Brazil to Punta del Este, Uruguay, creating an inland seaport in Bolivia; construction involves blasting through rock formations, straightening and dredging rivers and controlling tributaries to allow year-round shipping (Schemo 1996). Although originally estimated to cost $1 billion, by the time the gates of the Porto Primavera Hydro Dam on the Parana River were closed in November 1998, costs had expanded far beyond the original estimate. At least $3 billion will be required for future maintenance (Eckstrom 1996).

A critic of the Hidrovia Project pointed out that an old railway crossing the southern Pantanal already exists, and new railways could be built to Sao Paulo (Eckstrom 1996). Biologists and ecologists are extremely worried that the basic hydrology of the Pantanal is not sufficiently understood to make such major changes, and the long-term effects of Hidrovia may be totally unforeseen, ending in destroying this wilderness (Eckstrom 1996).

Ignoring the delays imposed for completion of the $10.5 million environmental studies, Paraguay began work blasting through rock on the Paraguay River north of Asuncion in June 1996. The Inter-American Development Bank contributed $7.5 million in 1991 for feasibility studies, but the studies were carried out by the same company performing the engineering work, and they did not appraise the work as a whole. The United Nations Development Programme's ecological advisor on the project, Dr. Enrique Bucher, protested this approach: "In order to understand the hydrological response of the system, you have to analyze it in its globality" (Schemo 1996b). The Hidrovia Project, may result in draining the Pantanal, according to a study by Victor Ponce of San Diego State University (Schemo 1996b, 1997). The Pantanal acts like a vast sponge, releasing rainwater gradually and year-round into the Paraguay River; the dams and drainage of wetlands will expose down-river areas to flash flooding and start drying out this vast marshland (Brooke 1995)

Pantanal wildlife has already been impacted by the Porto Primavera Dam, the first of several dams in the Hidrovia Project, which drowned 300,000 acres of floodplain, forest and grasslands. The dam builders financed "rescue" of animals as the area filled with water in late 1998, filmed for the National Geographic Explorer program ("Paradise Lost," April 28, 1999). This "rescue" was marked by extreme mistreatment of animals and a low survival rate. Black howler monkeys were knocked from tree tops by ramming the tree trunks with motorboats, causing babies to fall off their mothers' backs. Many of the monkeys had just given birth and were separated from family members. Injuries such as broken tails occurred. The monkeys were treated so roughly that they panicked and thrashed about. To subdue them, they were put in bags for transport. One monkey in a bag was hung over the side of the boat into the water, where it must have drowned during the trip to a holding area. Surviving animals were unceremoniously dumped in enclosures and cages in the holding area. Many of the monkeys, armadillos, opossums, foxes, snakes and other wildlife were crated and transported out of the area for donation to zoos and research institutes. Caiman were also captured, apparently for their hides, since they were not at risk if left in the water. Marsh deer were caught in nets dropped from helicopters, placed in a net and sent by helicopter to their permanent new home in a concrete enclosure. Many died in the process. Only a few of the animals, including some of the monkeys, were released in woodland nearby. The rescuers admitted only about 5 percent of the wildlife was "saved."

Although gold mining has been banned in the Pantanal, illegal mining is fouling the rivers with mercury and other pollutants (EI 2001). Only two small areas in the Pantanal have received official protection (Dugan 1993). The Pantanal National Park protects less than 1 percent of this wetland, covering only 550 square miles, of which 53 square miles are dry land; most of the park has been underwater for the past 20 years (Eckstrom 1996). The Taiama Ecological Station covers 43 square miles (Emory 1990). Thus, well over 90 percent of the Pantanal is privately owned, mainly by cattle ranchers. Whether it will be possible to preserve large portions of the Pantanal remains to be seen. A budding ecotourism industry has begun, but the damage may already be done. By 2010, the Pantanal may have dried out, or its hydrology been so altered that only remnants of this once vast wetland will remain, as occurred in wetlands of the upper Nile River after the building of the Aswan Dam.

A biological diversity survey of the Pantanal is being carried out under the direction of Conservation International, an organization that specializes in such studies, using Brazilian and American scientists and volunteers from Earthwatch Institute, a group that helps fund scientific studies. Many individual projects will be carried out by various Conservation Research Centers, where scientists, educators and conservationists can cooperate to help preserve the Pantanal (EI 2001). One project on a 7,000-hectare ranch will study ecosystem components and create a series of corridors for the future management of the region (EI 2001). Another will study the avian diversity of the Rio Negro region. The fish of the Pantanal, their diversity, ecology and environmental needs, will be the subject of another study (CI 2001). Should the Pantanal begin to die as an ecosystem, a very real possibility in view of its threats, conservationists can use the data that these scientists are compiling of the great wealth of wildlife and plants and how they are affected by the downstream water projects in order to urge protection through alteration or even cancellation of water projects. As the planet's greatest wetland, interest in its conservation reaches around the world, and the better its functioning is understood, the more coherent will be its defense.

Wetland Drainage: Page 3

Africa's two largest wetlands are Botswana's Okavango Delta and the Sudd marshes of southern Sudan. Both are threatened by massive water projects that may result in draining them for agriculture. Civil war in Sudan has so far prevented the construction of the Jonglei Canal, which would drain large sections of the wetland. The Sudd, covering 6,370 square miles when flooded by the Nile, is a maze of lakes, rivers and papyrus swamps among lush grassland and woodland savannahs (Simon 1995). It has the richest diversity of birds of any African wetland. The extraordinary shoebill, or whale-billed stork (*Balaeniceps rex*), the sole member of its avian family, is resident. This stork-like bird, whose scientific name means "whale-headed king," resembles a creature imagined by Dr. Seuss, with an outsized head and huge primitive beak ending in a long hook. The papyrus swamps that are the bird™s habitat are being drained throughout their range, which extends from Sudan south to Zambia. Fires set in the swamp, civil wars and large numbers of cattle tramping vegetation and destroying nests in the Sudd and elsewhere have disrupted protected areas such as the Akagera National Park in Rwanda (BI 2000). Tanzania's population of 2,000 birds is one of the few stable ones, newly protected as the country's first Ramsar site (BI 2000). Large numbers are captured for zoos, which exhibit this bird as a curiosity (Hoyo *et al*. 1992). The total population of this unique species was estimated at about 11,000 to 15,000 birds and declining in the late 1990s (BI 2000).

In the Sudd's floodplains and grassland are enormous herds of two antelope, the kiang, a subspecies of the topi (*Damaliscus lunatus tiang*) and the white-eared kob (*Kobus kob leucotis*). Almost a million of these antelope migrate to take advantage of grassland, forming the second largest aggregation of large mammals remaining in Africa after the wildebeest (*Connochaetes taurinus*) of East Africa. A film about these spectacular animals, fiMysterious Herds of the Sudan: Migration of the White-eared Kobfl (see Video, Mammals), shows this landscape as well, a little-known corner of the Earth whose abundant wildlife may be decimated if the Jonglei Canal is constructed. Another threatened species that is found only in the Sudd and wetlands of adjacent Ethiopia is the Nile lechwe (*Kobus megaceros*), a wetland antelope with elongated hooves that spread the weight of its body to keep it from sinking and help it leap through shallow water in bounds. This black antelope has ridged horns that arch over its back and a goat-like appearance. The *2000 IUCN Red List* lists it as near-threatened. The Nile lechwe's population totals about 30,000, but its range is restricted, and should its habitat be destroyed by water projects, it will be threatened with extinction (Nowak 1999).

In the middle of the vast Kalahari Desert is a brilliant, blue gem, the 11,000-square-mile Okavango Delta wetlands. This extraordinary wildlife oasis is the world's largest inland delta, a magnificent watery wilderness of shallow lakes, papyrus swamps, meandering rivers, wet grasslands and woodlands. World renowned for its large populations of zebra, antelope, African elephant (*Loxodonta africana*) and Cape buffalo (*Syncerus caffer*), the Okavango attract tourists in large numbers. Waterfowl are abundant, and the African fish eagle (*Haliaeetus vocifer*),

which resembles the American bald eagle, is common. Fifteen species of marsh-dwelling antelope are native, many of which are unique to this region. One of these, the threatened red lechwe (Kobus leche), has a large portion of its population, some 30,000 animals, in the Okavango (Nowak 1999). A race of this antelope in the wetlands of Zambia, the Kafue lechwe (*Kobus leche kafuensis*), lost half its population of 100,000 in 1970 after the construction of two huge dams for hydroelectric power on the Kafue River, which radically altered the natural flooding and dried out much of its floodplain habitat (Nowak 1999). Another race of this species, *Kobus leche smithemani*, native to the Bangweulu Swamps of northern Zambia, fell from about 250,000 in the 1930s to around 30,000 today, as a result of hunting and disruption of water levels by human manipulation (Nowak 1999). Yet another race, *Kobus leche robertsi*, native to the Luongo and Luena River drainages of northwestern Zambia, is now extinct (Nowak 1999).

Cattle ranches have been carved out of portions of the Okavango, but until recently, this immense swamp remained nearly intact. Its precious water supply is now in decline. A major feeder of this swamp, the Kavango River, is now having much of its flow siphoned off by the Namibian government for agriculture and residential use. Botswana has objected strenuously to this project, but Namibia is determined to ease a severe water shortage caused by years of drought. The Boro River, which emerges from the delta, may be dredged and diverted for diamond mines (Postel 1997). These projects may end in draining the Okavango and destroying the enormously profitable tourist industry in Botswana (Hawker 1997). This wetland receives irregular rain which brings flocks of flamingos to nest and renews the water table, but should its feeder river be blocked, many of its unique wetland animals and sizeable herds of endangered African elephant may be lost.

Another threat to the Okavango Delta is the planned spraying of 7,180 square kilometers with the pesticide endosulphan, beginning in the winter of 2001 (Tyler 2001). The purpose is to destroy tsetse fly, the dreaded vector for sleeping sickness or trypanosomiasis (Tyler 2001). This pesticide is toxic to small fish and many other types of insects that are primary sources in the food chain for aquatic birds, such as herons and egrets. These birds breed during the winter months when the spraying is planned, and the threatened Slaty egret (*Egretta vinaceigula*), which breeds in the delta and has a world population of only 5,000 to 10,000 birds, is at serious risk (Tyler 2001). Ironically, the tsetse flies were being effectively controlled by the use of cloth baits soaked in insecticide and hung on poles, but they were not properly maintained by personnel, and stocks ran out (Tyler 2001). Conservation organizations are protesting to the Botswana government to stop the spraying and consider the environmental effects. Until recently, sleeping sickness was not an easily controlled disease, killing thousands of Africans. Native hoofed animals are immune to the disease. Recently, however, a new drug, DSMO, used in the United States to remove facial hair, has been found to be almost a miracle drug in awakening victims of this disease from their comatose states, without the side effects of available medications. One pharmaceutical company agreed in early 2001 to donate 3 years™ supply after pressure from various health organizations. This makes spraying toxic pesticides even more unnecessary.*

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*fiOkavango. Jewel of the Kalahari,fl a series of three one-hour films by Partridge Films and the BBC, shows the great beauty and wealth of wildlife in this wetland. (See Video, Regional, Africa; see also the Book Section for several books about this swamp.)

Wetland Drainage: Page 4

Until the 20th century, wetlands covered large areas in Asia, from the swampy grasslands at the base of the Himalayas to the marshes and deltas of Thailand, Cambodia and Vietnam. With the growth in human populations and pressure to raise more crops, millions of acres were filled or converted to rice paddies. Thailand has lost virtually all

of its freshwater wetlands, and China, Laos and Vietnam have also incurred great losses. The majestic Sarus crane (*Grus antigone*) no longer nests in Thailand, and throughout Asia, cranes are threatened by loss of wetland habitat. Eight of the world's 15 crane species are found in Asia, and nearly all are considered endangered. They breed from high Tibetan reed lakes to coastal marshes, and all these habitats are being lost. The endangered black-necked crane (*Grus nigricollis*) breeds in high altitude sedge marshes and grasslands of the Tibetan plateau. Several of its important breeding marshes in western China have dried up as a result of intensive grazing and plowing of the steppe grasslands, and portions of its wintering wetlands in Bhutan are being drained (BI 2000). A dam planned on the Lhasa river also threatens wintering cranes. These beautiful cranes now number only 5,000 to 6,000 birds, and they are in decline (BI 2000).

Colorful Asian storks, once widespread, are now threatened with extinction as their habitat declines yearly. Seven species are now listed by BirdLife International in *Threatened Birds of the World* (BI 2000). They include the vulnerable milky stork (*Mycteria cinerea*), the endangered Storm's stork (Ciconia stormi), the vulnerable lesser adjutant (*Leptoptilos javanicus*), the endangered greater adjutant (Leptoptilos dubius), the endangered Oriental stork (*Ciconia boyciana*), the near-threatened painted stork (*Mycteria leucocephala*) and the near-threatened black-necked stork (*Ephippiorhynchus asiaticus*). Such a diversity of storks is found nowhere else on the planet. North America has only one species, the wood stork, and only the white stork is native to Europe. Some breed in the mangroves of Indonesia, and others, like the Oriental stork, which greatly resembles the white stork, winter in marshes in Japan, North Korea and Taiwan, where they face hunting, draining of wetlands, pesticides and pollution. The total world population of this bird is estimated at only 2,500 and declining (BI 2000).

Wetland Drainage: Page 5

In the United States, early American colonists began draining wetlands in the 17th century, and various laws encouraging this activity were enacted through the years. Over half of wetlands of all types, and some 70 percent of riparian, or riverside, wetlands in this country, have been destroyed (Rezendes 1996). Losses continue under the Clean Water Act's weak regulations that place the US Army Corps of Engineers in charge of issuing permits to developers who apply for permission to fill in wetlands. The Corps' major role has been the construction of dams and levees, dredging of ports, and other water projects responsible for causing numerous extinctions among the nation's wildlife. These regulations exempt small and temporary wetlands, such as vernal pools and prairie potholes, and the Corps has been less than vigilant in enforcing wetland protection (Williams 1996). Federal legislation should change the authority designated to oversee wetlands conservation from the US Army Corps of Engineers to the Department of the Interior. The United States may be the only country in the world to allow its dike and canal makers to oversee conservation of these ecosystems. Wetlands protection should be far stricter in both federal and state legislation to prevent further losses.

Unfortunately, these important wetlands are often not protected by law in the United States, or, in the case of states such as Massachusetts, are protected only by some towns and only if officially registered as vernal pools (Appel 1999). These pools are being destroyed, often intentionally, by developers and homeowners who fear that building on or near the pool would be restricted (Appel 1999). Even when the pool itself is not destroyed, its water supply can be cut off by building nearby. A prime area for wood frogs in Framingham, Mass., disappeared, even though registered as a vernal pool, because the surrounding 25 acres of woodland were cut to construct a cinema complex (Ridout 2000). The required 125-foot buffer area of woods that was left surrounding the pool did not supply enough runoff water; the vernal pool dried out and the frogs disappeared (Ridout 2000). The disappearance of turtles from many areas in the East has been blamed on the filling of these important habitats where they migrate to lay their eggs.

Many swamp forests in the East and in the Midwest, as well as potholes essential as breeding habitat for waterfowl and stopovers for the continent's shore birds, were drained with government subsidies. Iowa lost 98 percent of its

potholes; Minnesota, 75 percent; South Dakota, 35 percent; Montana, 27 percent and North Dakota, which had one-third of all these ecosystems, 49 percent (Williams 1996). The latter state's legislature discourages protection of the remaining potholes by requiring approval of conservation easements or purchase for conservation by an agricultural council (Williams 1996). This reflects the failure of federal and state governments to value wetlands for their ecological importance rather than for commercial purposes such as agriculture, construction or mining. In other parts of the world, similar attitudes prevail. The black-faced spoonbill (*Platalea minor*), a large white wading bird of Asia has been reduced to only about 700 birds (BI 2000). More than 200 of these birds winter in Taiwan's Chiku marsh, near the capital city, Tainan, now under great threat from development (WESPA 1994). A Taiwanese government official, when questioned about proposed drainage of the marsh, stated to CNN on January 6, 1994, "We can't stop our industrial progress for a few birds." Throughout the range of these endangered birds in east Asia's coastal wetlands, development has drained their habitats or converted them into aquaculture ponds (BI 2000).

Coral Reefs

The beautiful and diverse coral reefs of the world are today more threatened than they have been for many millions of years. A survey in the 1980s found that damage had occurred in coral reefs in 93 of the 109 countries where these rich ecosystems are found (Wells and Hanna 1992). At least 10 percent of coral reefs around the world had been damaged beyond repair, while 30 percent were in critical condition and expected to disappear within 10 to 20 years; another 30 percent were expected to die by 2050 (Carter 1997). Research in 1999 found further damage: one-third of all coral reefs were dead and 90 percent degraded to some extent.

In the Maldive Islands in the Indian Ocean, all the coral around inhabited islands has been excavated. This limestone material has been fashioned into houses. An estimated 95 percent of these reefs are dead or dying (Zuckoff 2000b). The result has been lowland flooding by the sea because these protective barriers were destroyed. Because of the growing numbers of tourists, tour boats, scuba divers and spear fishers, many ancient reefs are declining in species diversity or dying out altogether. In some areas, hotels are often built with inadequate pollution and erosion controls near coral reefs. Even touching a coral can harm the delicate outer layer, which can take 100 years to recover.

Dynamiting and poisoning reefs to obtain fish are methods banned throughout Asia, yet they regularly occur. David Doubilet (1999) has spent much of his life photographing coral reefs and has witnessed such activities. On one occasion while diving in the Philippines, he saw large areas of coral reefs reduced to white rubble. The cause was nearby boatmen who lobbed bottles of homemade explosives into the sea (Doubilet 1999). They were chased off by a marine official who fired a pistol round over the poachers' heads, but on inspecting the results in the coral reef, Doubilet saw fish spinning aimlessly in convulsions or belly-up amidst the craters of blast sites (Doubilet 1999). Beginning in the 1960s, Philippine fishermen pumped cyanide poison into 33 million coral heads at a rate of 330,000 pounds yearly (Chadwick 1999). Approximately 95 percent of the reefs of the Philippines have been destroyed from the combined effects of sewage pollution, dynamiting and the use of cyanide to obtain tropical fish for the pet trade (Chadwick 1999). These fish usually die within weeks from the cyanide (Wells and Hanna 1992). In the rich reefs surrounding Indonesia, a recent trade has begun for live fish which are kept in aquariums to be consumed in restaurants in Hong Kong and other major cities; the fish are stunned by small amounts of poison and the coral often dies after being sprayed (see Trade, Fisheries).

Seashell and pearl harvests have depleted many reefs of species important in controlling reef predators. The Crown-of-Thorns starfish of the western Pacific was once preyed on and kept in check by 12-inch giant triton mollusks, a species collected heavily for the shell trade. The fish that controlled populations of Crown-of-Thorns starfish have been killed off by fishing, further causing imbalance to reefs. Sewage or agricultural runoff promotes the growth of plankton that also encourages these starfish to multiply to pestilential levels, killing off large portions of coral (Chadwick 1999).

Siltation runoff from clear-cutting forests near shore and agricultural plowing has become major factors in the death of 95 percent of Philippine reefs and the dying of reefs in the Florida Keys and elsewhere. When silt comes to rest on live coral, the coral is smothered. Fertilizers and sewage encourage the growth of bacteria, viruses and diseases, such as aspergillosis, that have devastated hundreds of coral reefs in the Caribbean (Chadwick 1999).

Coral bleaching, in which colorful corals turn white and die, is affecting a growing number of reefs. Even a slight rise in ocean temperature can kill off the symbiotic algae living in the coral. The algae gives coral color and without it, the coral animals die. Global warming has been mainly responsible for gradually raising ocean temperatures, and should it continue, the majority of the world's reefs will die out. Household bleach, used by fishermen to stun fish, can also cause bleaching. UV radiation from ozone depletion may play a major role, as well by killing off the symbiotic algae (Chadwick 1999). In some cases, coral bleaching can be temporary, and corals can recover if water temperatures cool before too much time has passed or if the corals are not also being attacked by pollutants, pesticides or a different type of algae produced from fertilizer nutrients in the water.

The Great Barrier Reef has incurred die-offs of coral in many areas. This massive reef is considered one of the great natural wonders of the world, with a great diversity of fish and corals. Coral bleaching has killed various parts of the reef in recent years, and in 1998, the warmest year ever recorded, large sections of the reef died, leaving white skeletons in place of dazzling fish and colorful corals (Zuckoff 2000b). Some reefs recovered when temperatures cooled, but most did not. Scientists meeting at the fourth meeting of the International Coral Reef Symposium in 2000 warned that global warming and other threats must be stopped if the world's coral reefs are to be saved (Zuckoff 2000b). At the present rate of destruction, one scientist estimated that coral reefs will be gone in 30 to 50 years (Zuckoff 2000b). Global warming is not being arrested, however, as countries, led by the United States, the largest producer of greenhouse gases, continue to pollute the atmosphere.

Mangrove Destruction

In the Americas, mangroves grow as far north as southern Florida and the Florida Keys, throughout the Caribbean region; and in South America, they occur in a narrow band lining the Amazon River and on the coasts of French Guiana and northern Brazil. Mangroves are also abundant in river deltas of West Africa, portions of the Middle East, east to Malaysia, Papua New Guinea, northern Australia and on many western Pacific islands.

The Sundarban mangroves surround the Ganges Delta, extending along the coasts of eastern India and Bangladesh. They cover 2,300 square miles and penetrate far inland along the Ganges River, forming an intricate maze of rivers, creeks and canals that are flooded daily by ocean tides (Dugan 1993). Wildlife is abundant in these mangroves. At least 35 species of reptiles, 270 bird species and 42 mammal species are native (Dugan 1993). The most famous of these is the magnificent Bengal tiger (*Panthera tigris bengalus*), whose largest population may be found here. India has set aside a large reserve for tigers and other wildlife in its portion of the Sundarbans; as many as 350 to 400 tigers are present in Bangladesh's portion, with 250 to 300 in India's (Dugan 1993). Even in this maze of mangroves, however, tigers are under siege from poachers, and since the early 1990s, their numbers have declined even here from habitat loss, poaching and loss of prey animals to hunters.

The Sundarban mangroves are heavily exploited by the over 300,000 people who live here. Each year 9 million cubic metres of timber and pulpwood and 106,400 tons of fuel wood are cut by Bangladeshi and Indian natives (Dugan 1993). Overcutting has affected the fisheries habitat that provides about 150,000 tons of fish per year for the 10,000 fishermen in these mangroves (Dugan 1993). So many of the outer island mangroves have been destroyed that storm surges caused by cyclones now move much further inland, leaving destruction and loss of life in their wake (Hauser 1992). Fragile mangroves have been destroyed for a fishing jetty and prawn culture area inside the Indian

Bhitarkanika Sanctuary for endangered Olive Ridley Sea Turtles (*Lepidochelys olivacea*). These projects were funded by the World Bank. This prime wildlife area is vital to white-bellied sea eagles and threatened Indian smooth-coated otters of the same species as Maxwell's otter (see above). The Olive Ridley sea turtles experienced a major die-off in February 2000.

The cutting of mangroves in southeast Asia has destroyed thousands of acres to supply paper mills in Japan (Collins 1990). Prior to the Vietnam War, scientists estimate that at least 1,000 square miles of the Mekong Delta were mangrove and paperbark forest. Eleven million gallons of herbicide defoliants (known as Agent Orange) were sprayed during the war, destroying half the delta wetlands, or 480 square miles of mangrove and 100 square miles of paperbark (Dugan 1993). To compound the damage, the forests beyond the mangroves were burned and sprayed with herbicides, and canals were dug by the U.S. armed forces to drain the flooded areas (Dugan 1993). Much of this land remains poisoned and infertile 35 years after the end of the war; replanting is taking place on non-poisoned acreage. The human toll has been significant: thousands of Vietnamese died from the effects, and many children born since the war have had a high incidence of birth defects, serious skin disease and tumors; American soldiers exposed to these chemicals suffered a wide range of cancers and other major health problems. Only recently has the US government acknowledged the full range of the effects of these herbicides and paid compensation to ailing servicemen.

The Mekong River delta is native to 260 species of fish, 35 reptile species, 6 amphibian species, 386 bird species and 23 mammal species (Simon 1995). Among these are the endangered Estuarine crocodile (*Crocodylus porosus*), a species in decline throughout its southeast Asian range, and the threatened eastern Sarus crane (*Grus antigone*), which disappeared from Vietnam during the war but later returned (Simon 1995). One of the rarest birds in the world, the giant ibis (*Pseudibis gigantea*), is the largest of all ibises, a silvery-gray bird with pink legs. The Mekong Delta system in Cambodia was its stronghold in the 1920s, where it was commonly seen, but a 1994 survey found no giant ibis. Wetland drainage for agriculture, hunting and deforestation have pushed it to the edge of extinction. Extinct in Thailand, only two birds have been seen in southern Laos in recent years Œ in 1993 near a proposed protected area (Collar *et al*. 1994). Once native to the Mekong Delta in Vietnam, it was probably extinguished during the war. Cambodia has some lowland wetlands and may have undiscovered populations of giant ibis, but at present the estimated total world population is 50 birds and declining (BI 2000).

At present, the greatest threat to mangroves worldwide is the farmed shrimp industry. Mangroves are natural nurseries for shrimp, and this industry destroys the mangroves by cutting them in wide swaths to make room for artificial ponds. These ponds are closed off to prevent the shrimp from swimming back to the sea. Without the natural cleansing of the tides, the ponds soon become polluted and laden with chemicals added by the farmers. Although not all farmed shrimp are raised in this environmentally destructive manner, in some countries this type of farming predominates. The worldwide shrimp farm industry is worth at least $8 billion (Mydans 1996) and produces 783,200 tons of shrimp per year, about 30 percent of the world's shrimp production (Nixon 1996). Fifty countries now farm shrimp, many with aid from the World Bank. The governments of India and Ecuador have banned the further cutting of mangroves for shrimp farms, but in Ecuador, 85 square miles of mangroves were illegally cut after the ban. In the Philippines, 1,000 square miles of mangroves, 67 percent of the country's total, were destroyed between 1920 and 1980, most being converted to ponds for farming shrimp and milkfish (Dugan 1993).

Grassroots environmental organizations have recently appealed to international conservation groups and lending banks to stop funding the farmed shrimp industry and to the public to boycott all farmed shrimp. One such group, the Seattle-based Mangrove Action Project, has united with The Sierra Club of Canada and other organizations to lobby against tropical shrimp farms. The shrimp pond industry may die out on its own, however, because of disease outbreaks in the ponds. Various types of virus and bacterial infections have spread through shrimp ponds because of their stagnancy and the crowding of shrimp. More than 42,000 acres of ponds in Ecuador now lie fallow, having been swept by disease, and many fishermen and shrimp farmers now see the wisdom in protecting the mangroves because these trees are able to filter water and maintain a clean environment for shrimp far more efficiently than human-made holding ponds along the coasts (Nixon 1996). High-technology aquaculture buildings have been constructed that use aerated and filtered water and operate independently of natural ecosystems. Some of these facilities have been

constructed in Thailand and elsewhere. They are a far more environmentally friendly method of producing shrimp. A key element is the captive-breeding of shrimp in such a facility, rather than removal of wild larvae from the ocean.

Noise, Boat Collisions and Debris

The once quiet oceans now rumble with huge cargo, cruise and naval ships whose noisy engines drown out the delicate rumblings, and songs whales make to establish territory and communicate, as well as the myriad sounds other creatures emit in the ocean depths vital to their survival. The North Atlantic, Mediterranean and Baltic are especially busy shipping lanes. Wildlife now has new and lethal noises to cope with. The Navy has been testing anti-submarine sonar called Low Frequency Active. Powerful sonar waves are broadcast underwater to test a means of detecting quiet enemy submarines (White 2000a). These sonar waves can travel hundreds of miles and be extremely loud. Humpback whale (*Megaptera novaeangliae*) males emitting their complex, haunting songs to establish territory have become silent or moved away when these waves were broadcast. More ominously, testing in 1995 off the coast of Greece coincided with an unusual stranding of Cuvier's beaked whales (*Ziphius cavirostris*) resulting in the deaths of these seldom-seen whales. In March 2000, Ken Balcomb, a biologist from the Center for Whale Research who is familiar with sonar, was present when a stranding occurred while Navy tests were taking place nearby. Fifteen animals stranded, including dense beaked whales (*Mesoplodon densirostris*) and other species of beaked whales, a Minke whale (*Balaenoptera acutorostrata*) and a spotted dolphin (*Stenella frontalis*). All washed up on the shores of a Bahamian island; when pushed back into deep water, they were unable to remain upright, clearly unbalanced and disoriented, and nine died (White 2000a). Along with Harvard biologist Darlene Ketton, Ken Balcomb performed necropsies on several whales, finding their ears full of blood and, in one case, hemorrhages striped the lungs; further testing discovered that a whale had suffered a concussion, apparently the result of acute trauma from pressure (White 2000a). A press conference organized by the Animal Welfare Institute following these findings featured Ken Balcomb and other whale experts, who attested to the fact that the sonar is reckless, unnecessary and lethal to whales. Soon after, the Navy canceled testing of active sonar off New Jersey, as well as its scheduled tests on sperm whales in the Azores (White 2000). This technology fills the ocean with penetrating sound waves that greatly disturb or kill marine mammals, interfering with their own sonar and natural behavior.

A major cause of mortality for Florida manatees is collisions with boats. Manatees struck by motorboats or their propellers can be killed instantly, or may suffer slow, painful deaths from deep slashes and internal injuries. In some cases, these strikes have been intentional. CNN recently reported a case of a woman who witnessed a young man in a motorboat repeatedly driving over a mother manatee and her calf until both were dead. She called the state law enforcement division, but by the time officers arrived, the perpetrator was gone. Many calves are orphaned when their mothers are killed, and only if they are found within hours can they be rescued and cared for by Sea World or other aquariums in Florida. In the first half of 2000, the state determined that 61 deaths were caused by watercraft, just short of the all-time high of 67 for the entire year of 1999. These figures may be lower than the actual mortality, since some manatees may be struck and sink, while others, whose bodies are found, may show no outward sign of injury, having been struck by the bow or side of a boat. These collisions occur with such frequency that virtually all adult Florida manatees have propeller scars on their backs.

The present system of posting speed limits has not been effective in reducing collisions, since so many boaters refuse to obey them and enforcement is inadequate. Manatees swim long distances to find warm water during the winter, passing through shipping lanes and most of southern Florida's navigable waters. This creates a problem that the State of Florida and the Fish and Wildlife Service have not properly addressed, yet one that must be solved to preserve this species. Apparently, manatees do not hear motorboats coming. Research is taking place on the placement of some type of noisemaker attached to the underside of boats to warn them. Even this would not result in a halt to all manatee-boat collisions, however, because these animals are too slow-moving to avoid high-speed boats.

Boat propeller guards would also reduce manatee deaths and injuries, as well as human injuries caused by accidents with these sharp blades, but they have not been required by law. The number of pleasure craft in Florida has risen exponentially in recent years, with few laws and regulations governing those who propel them, such as strict regulations on sobriety and competence to handle the boats. Heavy boat traffic has also resulted in human fatalities and injuries from collisions.

Two lawsuits were filed in January 2000 on behalf of the Florida manatee. A coalition of 18 environmental and animal welfare groups, led by the Save the Manatee Club, sued the State of Florida, the US Army Corps of Engineers and the US Fish and Wildlife Service. The Animal Welfare Institute's companion organization, the Society for Animal Protective Legislation, has worked with the coalition's legislative team to obtain $500,000 from the Congress for manatee protection. The corps was sued for its repeated issuance of permits for development in manatee habitat without analyzing the cumulative effects of the permits on the species or its habitat. The suit charges the Fish and Wildlife Service with failure to properly enforce the Marine Mammal Protection Act of 1972 and the Endangered Species Act to prevent mortality and to conserve the species. The US Fish and Wildlife Service failed to designate adequate sanctuaries for manatees where boat traffic would be restricted, reducing its proposed list of sites from 150 in Florida to 10 to 15 (Daley 2001).

The second suit was filed against the Florida Fish and Wildlife Conservation Commission, which has not complied with the Florida Manatee Sanctuary Act of 1978, enforced speed limits, or taken other measures designed to protect these vulnerable animals. The mortality rate from all causes is far greater than the number born, pushing manatees toward extinction. Florida Governor Jeb Bush angered conservationists in late 2000 by allowing the licensing of more boat slips in Sarasota, although the county had not completed a required plan to protect manatees (Daley 2001).

The future is bleak for the approximately 3,000 surviving Florida manatees unless dramatic action is taken (Daley 2001). Their survival has become critical. Other causes of mortality, such as death from red tide, pollution or cold weather, add to the toll. In 2000, for example, 273 manatees died from all causes, close to 10 percent of the entire population (Daley 2001). Since manatees have a single young only every 5 to 7 years, they cannot sustain such losses. These gentle and affectionate animals have been on Earth for 45 million years, yet a lack of concern and willingness to alter our recreational boating habits may eliminate them in Florida. Elsewhere in the range of these manatees, far stricter regulations have been imposed on boat traffic. In Belize, for example, very few manatees have boat propeller scars because many areas are off-limits to all motorized boats, and tours are conducted in boats propelled by poles.

There are two major threats to whales and marine mammals causing their elimination in many areas. Fishing vessels throw out ropes, nets and other debris that entangle marine mammals, often lethally, and vessels of all types present the danger of mortality through collisions. One or more highly endangered North Atlantic right whales (*Eubalaena glacialis* die each year from rope and net entanglements or collisions with ships; their population is only at about 300. In 1995, a whale of this endangered species became wrapped in lobster line and died off the Rhode Island coast. In September 1997, another whale became hamstrung with nylon netting around his head, towing a 9-foot sea anchor near Nova Scotia; it took 8 1/2 hours to free him, after a 25-kilometer chase by a rescue team. A young blue whale (*Balaenoptera musculus*) was killed when a ship collided with it; the ship entered a Massachusetts port with the whale impaled on its bow. In early 2001, three dead fin whales (*Balaenoptera physalus*) washed ashore along the Atlantic coasts of the United States, killed by ship collisions. For North Atlantic right whales, such collisions may end in their extinction, unless means are found to prevent them. These whales have a single calf only once every five years and are dying at such a rate that scientists expect their extinction within less than a century.

Plastic bags and fishing gear have been found to strangle and suffocate endangered sea turtles, marine mammals and sea birds. Endangered albatross on Laysan Island are among the many species to have died after ingesting plastic materials. They also feed their chicks plastic items they mistake for food, unintentionally killing them. Sea turtles, dolphins, whales and sea lions around the world are drowning and strangling in fishing lines and nets. One endangered fin whale that washed ashore dead in Biscayne Bay, northern Spain, in 1997 was found to have ingested huge amounts of plastic sheeting and bags that clogged its digestive system. Each year millions of balloons are

released to the winds, and untold numbers end up floating in the oceans, a peril to wildlife. One young sperm whale (*Physeter catodon*) starved to death after swallowing a single balloon that blocked its intestine. Endangered sea turtles die after consuming plastic bags and balloons, mistaking them for jellyfish. Non-biodegradable plastics and nylon nets and ropes in the ocean will present lethal threats to wildlife for the indefinite future. Although international treaties have been signed that regulate such dumping, to date no national or international program has attempted to remove debris, such as plastic items, nets and fishing lines, from the oceans.

Toxic Chemicals

Some chemicals, such as Polychlorinated Biphenyls (PCBs) and pesticides, have entered aquatic systems, causing birth defects in water birds and other wildlife. PCBs, manufactured by General Electric, were used for decades in refrigerators and other industrial uses until it was discovered that when released to the environment, they had serious effects on wildlife. American bald eagles have been among the species affected by PCBs, producing chicks with crossed bills and other defects.

Toxic Chemicals: Page 1

Beluga whales (*Delphinapterus leucas*) in the St. Lawrence River have also been affected. Isolated from members of their species living further north for thousands of years, they have declined dramatically in recent years. Many of these beautiful whales, known for the lyrical songs they sing to one another, have been found dead with tumors, malformations and impairment of female reproductive organs. This river, which links Lake Erie to the Atlantic Ocean, has become severely polluted with chemical contaminants, resulting in declines in wildlife. American eels (*Anguilla rostrata*) accumulate high levels of toxins on their spring migration from the Great Lakes down the St. Lawrence River to the sea and contaminate the Belugas when they feed on them. A major source of PCBs in the river is a sunken barge in the Gulf of St. Lawrence, which has been oozing these toxins for more than 25 years; its cleanup is difficult because there is fear it will break apart either on its own or if moved (Nickerson 1996).

The St. Lawrence belugas numbered about 5,000 in the 1600s, but whaling, which went on until the 1940s, reduced their population to about 2,500 (Katona *et al*. 1993). Before they could fully recover, contaminants from industries surrounding the Great Lakes and St. Lawrence seaway took a tragic toll on them. Today, only 400 to 500 belugas remain in this river. A study by Dr. Pierre Beland of the St. Lawrence National Institute of Toxicology in Quebec found that 40 percent of all belugas necropsied had malignant tumors in their digestive systems, mouths, esophagi, intestines and respiratory systems. Two percent of the belugas found at the mouth of the Saguanay River were visibly deformed. PCBs, which cause malformations in mammals and birds, were found at levels up to 3,400

parts per million (ppm) in the milk of a lactating female beluga and up to 576 ppm in blubber (Katona *et al*. 1993). Fish is unfit for human consumption if it contains 2 ppm of PCBs.

In 1976, the United States banned the manufacture of PCBs, and other industrialized countries followed. But in the nearly 50 years that they were manufactured, an estimated 3.4 billion pounds had been produced, and they have become pervasive in the environment, spreading on air currents and through aquatic food chains. PCBs are now found in animals thousands of miles away from locations where these chemicals were used, in the blubber of whales and the milk of nursing polar bears (Colborn *et al*. 1996). Once PCBs are deposited in the fat of animals and humans, they remain indefinitely and do not biodegrade. These and related chemicals continue to cause birth defects and reproductive failure in wildlife (Colborn *et al*. 1996). Virtually all humans carry PCBs and other persistent chemicals in their body fat, and a nursing mother passes these chemicals on to her baby (Colborn *et al*. 1996). The higher the animal on the food chain, such as birds of prey, whales, seals and land predators, the higher the concentrations of PCBs and chlorinated hydrocarbons like DDT, multiplying up to 3 billion times as they move up the food chain from microorganisms to polar bears (Colborn *et al*. 1996).

PCBs have also contaminated killer whales (*Orcinus orca*) in the Pacific Northwest. The Institute of Ocean Sciences tested 47 of these giant dolphins living off the British Columbia coast, finding levels two to five times as high as belugas in the St. Lawrence River (NG 2000). Just to the south, the killer whales off the San Juan Islands of Washington State are in decline, with the highest PCB levels ever found in wildlife (White 2000b). Deformed polar bear cubs have been found in Norway's Svalbard Islands. Researchers in 1996 found seven cubs with both male and female sex organs (NG 1999). These islands receive three times the PCB exposure of northern Canada, where only one such case has been seen (NG 1999). Pesticides and PCBs are carried here by air and water from Europe, North America and Asia.

During the 1990s, bald eagles (*Haliaeetus leucocephalus*) feeding on seagulls near Lake Superior accumulated contaminants 20 times higher than fish-eating birds of the same area (Colborn *et al*. 1996). Bald eagle chicks hatched in the Great Lakes were found with severe birth defects, from crossed bills to missing eyes, clubbed feet and a wasting disease that causes chicks to weaken and die (Colborn *et al*. 1996). Scientists have detected high residues of contaminants such as dioxin, PCBs and furans in the eagles. PCBs are the most likely cause of these abnormalities, but several chemicals might interact with toxic effects (Colborn *et al*. 1996).

Almost the entire length of the Hudson River has been contaminated by PCB dumping and outflow from a General Electric plant. Seepage of PCBs continues from the plant foundations, even though the chemical is no longer produced here, rendering fish from the river commercially unmarketable. After decades of conservation, striped bass recovered from heavy fishing in the Hudson River, but they contain such high amounts of PCBs that if caught by sport fishermen, they cannot be sold, and pregnant women are warned not to eat them. The removal of these residues from the Hudson and other river bottoms has not been carried out because of the difficulty of containing them in such a way as to prevent their dispersal into the atmosphere. General Electric was ordered to dredge the PCB residues in 2000, but local communities along the Hudson River have expressed opposition, fearing that they would disperse throughout the river. These chemicals may be impossible to eliminate from the Earth.

Like PCBs, persistent types of pesticides and herbicides, even in minute quantities, can be stored in the tissues of aquatic organisms and accumulate in greater and greater amounts in the ascending food chain. These chemicals can accumulate to toxic levels, killing the animals or interfering with their production of eggs, a known effect of chlorinated hydrocarbon pesticides, primarily DDT, that nearly caused the extinction of the Peregrine falcon (*Falco peregrinus*) in North America and great declines in bald eagles and other birds. The most injurious of these, DDT, dieldrin and chlordane, have been banned in the United States for most uses, but are used in foreign countries and remain in many areas where they were manufactured.

Toxic Chemicals: Page 2

Although persistent pesticides of the DDT family have been banned in the United States, they are still manufactured here and exported for control of malaria to many tropical countries. DDT is still present in a 17 square mile dumping area in the coastal waters off California. Montrose Chemical Corporation and two other companies dumped some 100 tons of DDT between 1947 and 1971, when it was banned. These ocean residues continue to enter the food chain through fish and other organisms. This has affected birds who feed on these fish, including brown pelicans and bald eagles on the California coast, who still laid thin-shelled eggs as a result of DDT contamination of their food supply 30 years after the ban. Highly toxic pesticides banned in the United States are still being used around the world, killing large numbers of birds and other wildlife. Diazinon, a pesticide commonly used on golf courses in the United States, and highly toxic to geese and other birds, was recently banned in the United States, along with Dursban, a commonly used lawn chemical. Pesticides and related chemicals that kill and cause mutations in wildlife are indeed still being broadcast in the United States as well as in other parts of the world. Only with more oversight and strong legislation to limit use and export of these chemicals can wildlife and aquatic ecosystems be protected.

DDT and other pesticides contaminate entire ecosystems in tropical countries, and some North American birds winter in areas where these chemicals are still used. Between 1992 and 1994 alone, the United States exported at least 247 million pounds of banned or restricted pesticides to the rest of the world. DDT, for example, is widely used for malaria control in Africa and Asia. Virtually no laws restrict this trade, which has the potential of causing major wildlife declines and extinctions.

In agricultural areas in northern Florida, American alligators (*Alligator mississipiensis*) have been found with abnormalities and poor reproductive success thought to have been caused by pesticides in their food supply (Colborn *et al*. 1996). Many synthetic chemicals react on animals in a manner similar to hormones. Dicofol, a pesticide related to DDT, was widely used in the vicinity of Lake Apopka, finding its way into the waters and causing abnormalities in alligators. Males developed unusually small penises and defective testicles, and females had abnormal eggs and sex organs (Colborn *et al*. 1996). The male alligators in this lake had elevated levels of female hormones, equal to those in normal female alligators, and one-fourth the normal level of testosterone; females had estrogen levels double the norm (Colburn *et al*. 1996). The reproduction of alligators in the area has nearly ceased altogether, with almost no eggs hatching (Colburn *et al*. 1996). Red-eared turtles of Lake Apopka, considered unlikely to be affected by this pesticide since they are plant-eaters, surprised researchers by exhibiting reproductive difficulties as well. Many turtles discovered had not developed normally as either male or female (Colborn *et al*. 1996).

Toxic Chemicals: Page 3

Within the past few decades, an increasing toll of wildlife has been taken by toxic chemicals in aquatic environments. Massive seal kills have occurred in the North Sea, and in January 1996, the body of an endangered sperm whale (*Physeter catodon*) washed up on a Danish beach. Analyses of its tissues revealed dangerous levels of heavy metals Œ so much mercury and cadmium that the intestine had to be buried at a special dangerous waste site. The amount of toxic cadmium was 20 times higher and the quantity of mercury double that normally found in fish. The North Sea has become extremely polluted, laden with toxic chemicals from industry and untreated sewage.

Off the west coast of Mexico, a large number of dead dolphins and Gray Whales have washed ashore since 1997. Some were the apparent victims of cyanide poisoning. Drug traffickers use a cyanide-based chemical to mark ocean

drop-off sites, and this chemical is thought to be responsible for poisoning these and hundreds of other marine mammals and fish. Some Gray Whales that wash ashore may be suffering other maladies related to toxic chemicals or contamination, combined with a lack of food. Numbers have risen off U.S. coasts: 278 in 1999, more than 300 in the first half of 2000 (White 2000b). The number of Gray Whale calves also declined from 1,520 in 1997 to 282 in 1999 (White 2000b). Many of the dead whales were emaciated.

Very high levels of methyl mercury have been detected in the Everglades. A study by Greenpeace found that this highly toxic metal was emanating from trash incinerators operating on the East Coast. Endangered Florida Panthers (*Felis concolor coryi*) have been found dead with toxic levels of mercury in their bodies. These endangered cats, an unusual subspecies of the Cougar, are close to extinction, with a population of fewer than 30 animals. Mercury is also present in sewage sludge, much of which is spread on land as fertilizer. In one year alone, 1996, the state of New Hampshire spread 1.6 tons of mercury on land (Giordano 1998). Their dairy farms are among the users of sludge obtained from chemical treatment plants in Massachusetts and other states (Giordano 1998). Common Loons, known for their haunting cries once heard in virtually every one of New Hampshire's thousands of lakes, have declined precipitously in recent years, their bodies laden with very high levels of methyl mercury (Giordano 1998).

In spite of the clear danger presented by mercury, little has been done to limit its use and disposal. Only Vermont has passed legislation that bans disposal in landfills and requires labeling of products such as fluorescent light bulbs, light switches, batteries for hearing aids and watches and thermometers. Mercury is also used in dental fillings. Boston banned the sale of household mercury thermometers in 2000, and the ban is expected to be extended statewide in 2001 (Daley and Kremmer 2001). Several other states are considering legislation to require labeling of mercury-containing products and banning their disposal by flushing or placing in the trash. New York State proposed legislation in 2001 that would eliminate the use of mercury in such products beginning in 2004 (McKinley 2001). The Environmental Protection Agency and the New York Department of Environmental Conservation began to cooperate in regulating mercury sent into the air by incinerators five years ago, but coal-burning power plants, which emit about 30 percent of all mercury emissions, are not subject to any federal or state restrictions (McKinley 2001).

Toxic mercury residues from metals companies is often shipped out of the country to nations that accept them. Now, however, some countries are unwilling to allow such shipments. One cargo ship headed for Bombay, India, in January 2001, carrying 20 tons of mercury reclaimed from a Maine factory, set off a tempest of protests by environmentalists in that country who denounced the "toxic trade" (Daley and Kremmer 2001). At least 12 factories in the United States have stocks of tons of mercury, some of which is used in a chemical process to produce chlorine (Daley and Kremmer 2001). India is a major user of industrial mercury as well, but resents becoming a dumping ground for other countries (Daley and Kremmer 2001).

Toxic Chemicals: Page 4

Within the past decade, sea turtles in Florida Bay and the surrounding waters have shown signs of disease caused by toxic chemicals. Hundreds of turtles have been found dead or dying, some with massive tumor growths on their skin, covering their heads, necks and legs. It is thought that these growths are caused by a virus that attacked the turtles because of their lowered immunity system, which was in turn caused by pollution such as runoff from farmland or inadequate food when sea grasses died off. Some of these turtles have been saved by placing them in aquariums for months to build up their immune systems. Because of the increasing number of sick turtles seen, however, and the other problems that these sea turtles face, many scientists now believe that within 50 years, sea turtles will have disappeared from Southeastern waters.

Chemical runoff from agriculture in the reclaimed marshes of central Florida is thought responsible for the outbreaks of red tide organisms that killed hundreds of endangered Florida manatees (*Trichechus manatus latirostris*)

in 1996, devastating their populations. A total of 415 manatees died that year, a record number. Of these, a large percentage died from the toxins. The hundreds of dying manatees, who exhibited no symptoms prior to their deaths, caused great concern among scientists and conservationists who cooperated to discover the cause. Analyses of tissues carried out by the Florida Marine Research Institute and federal, state and private agencies finally concluded that red tide toxics produced by dinoflagellates were the cause. Some of the sick Florida manatees exhibited neuromuscular problems consistent with those previously described in manatees exposed to red tides and were taken to a rehabilitation facility at Lowry Park Zoo in Tampa (Turner 1996). Three females recovered over a period of three days, during which time they required assistance to stay afloat for breathing (Turner 1996).

Although red tide is a natural phenomenon, scientists believe that these tides, which have been occurring with greater frequency in recent years, are erupting as a result of effluents, such as sewage and agricultural fertilizers and pesticides (Broad 1996). The average number of Florida manatees that die each year was 100 or fewer prior to 1990, but since then, each year 200 or more die. The effects of pollutants may be a major factor in the doubling of their death rate at a time when toxic chemicals have become pervasive in Florida waters. Since a female manatee has only one young every five to seven years, this death rate is far greater than the recruitment rate.

Toxic Chemicals: Page 5

Pollution-caused mortality of wildlife was, until recently, rare, occurring in isolated areas in the world's oceans. Increasingly, however, these poisons are becoming widespread, and the effects on ecosystems and individual species have been serious. Red tides have affected the Chinese coast in recent years, causing massive fish kills and wiping out fish farms (Chu 2000). They are attributed to sewage dumping. In Hong Kong, where a red tide covered 2,000 square miles, 700,000 tons of sewage is dumped yearly into the nearby Bohai Sea (Chu 2000). Long-term dumping of sewage, toxic chemicals and fertilizer is killing all fish and sea life, creating "dead zones." A dead zone in the Gulf of Mexico off the delta of the Mississippi River covers 7,000 square miles, the size of New Jersey; it spreads west to the Texas coast (Yoon 1998). Caused by a lack of oxygen, 50 dead zones were found in oceans and seas throughout the world by 2000. Cruise ships now number in the thousands, and each one generates a million gallons of waste water, 200,000 gallons of sewage and 25,000 gallons of oil-contaminated water each week, according to the Bluewater Network (Johnston 2000). Even small motor boats are heavy polluters of the air and water, emitting toxic fumes and leaving trails of oil and gasoline in the water.

Toxic Chemicals: Page 6

The spectacled eider (*Somateria fischeri*), a beautiful duck of Alaska and arctic Russia, has incurred great declines that may be related to ingestion of toxic chemicals. The Iowa-sized Yukon-Yuskokwim Delta of western Alaska had 100,000 of these ducks breeding here in the 1970s, but beginning in 1986, they lost 14 percent of their population each year; 95 percent of their original numbers are now gone, leaving only about 5,000 birds (Dunkel 1997). In 1993, the species was listed as threatened on the Endangered Species Act, and a task force set about trying to discover the causes. They found that many of the birds had high levels of lead from Eskimo hunting with bird shot. Although 34 of the 42 Eskimo villages in the delta have passed resolutions in favor of using steel shot over lead shot, most natives apparently believe that the birds are dying out from being studied and handled by biologists (Dunkel 1997). One Fish and Wildlife Service biologist observed a spectacled eider dying of lead poisoning: "She was flopping along [on the ground] and couldn't lift her head . . . She died within an hour" (Dunkel 1997). Lead in sub-lethal concentrations can cause females to abandon nests and males to become infertile.

Lead poisoning has killed other wildlife as well. The magnificent and rare Steller's sea eagles of Russia's

Kamchatka Peninsula and northern Japan have been dying of lead poisoning from eating carcasses of deer killed by Japanese hunters (Garcelon 1999). Lead shot cannot be used by United States waterfowl hunters (other than native Americans) because of massive bird-kills in marshes where lead shot accumulated.

Until February 1995, the wintering area of spectacled eiders, where they spend 10 months of the year, was unknown. The Fish and Wildlife Service had attached radio transmitters to several of these ducks, only to find the signals fading during the winter. One radio, however, continued to send out signals which were detected and located by biologists flying over the Bering Sea in a small plane (Dunkel 1997). To their amazement, they saw flotillas of these ducks, gathered in dense flocks south of St. Lawrence Island off western Alaska. Packed close together, their body heat helped keep the ice open. DNA studies determined that these ducks comprised the entire world population of the spectacled eider, converged from Alaska's North Slope, the western Alaskan delta and arctic Russia. Each returns to the location where it hatched, and when one population declines, there is no recruitment from the others (Dunkel 1997). This makes the decline in the Yukon-Kuskokwim Delta population all the more serious. The Bering Sea has been found to contain cadmium, selenium, strontium and other contaminants in high concentrations, which might be another explanation for the decline in these ducks (Dunkel 1997). Their disappearance coincides with the downward population trends of Alaskan mammals that were abundant only a few decades ago. Harbor seals of the Bering Sea have plummeted 60 percent since the 1970s; fur seals, 20 to 40 percent and Steller's sea lions (*Eumetopias jubatus*), a disastrous 80 percent, pushing them to endangered status (Dunkel 1997). Overfishing may play a role in these declines, but since the spectacled eider feeds on mussels and other bivalves, as well as surface invertebrates, and has declined concurrently with the others, contaminants are apparently playing an important role.

Toxic Chemicals: Page 7

The rivers of Europe may be the most polluted and changed by diversion, dams and channeling in the world. The Rhine, considered the "great open sewer of Western Europe," has lost the majority of its native fish, but pollution control efforts are beginning to show results (Simons 1995). After an absence of 40 years, a single, stranded Atlantic salmon (Salmo salar) appeared after flooding of the Rhine in the Netherlands in the spring of 1995 (Simons 1995). Atlantic salmon are now being reintroduced to rivers of Europe where they have been absent for many decades. A recent report on the Rhine's cleanup status concluded, however, that although much improvement had been made, heavy metals, dioxin, chlorine compounds like PCBs, herbicides and animal manure remain in sediments and are still released along parts of the river. Common otters (*Lutra lutra*) in Germany have dangerous levels of toxins in their kidneys, livers and fat, and cormorants along the river are laying eggs with thin shells (Simons 1995). Every year in the European Union, 250 million tons of solid industrial waste are produced, most of which is deposited in landfills which can leech into the groundwater (Lanz 1995).

As a result of population and industrial growth, incidents of wildlife killed by pollution in Africa have become more frequent. Formerly pristine lakes in the Great Rift Valley of East Africa are breeding grounds for 80 percent of the world's flamingos. Greater and lesser flamingos by the millions nest and feed in high-altitude, briny lakes. Lakes Nakuru and Bogoria in Kenya have become polluted in recent decades by factories that emit heavy metals and other industrial wastes. People have built towns and cities along the shores that discharge large amounts of untreated sewage into the lakes. Since 1993, several mass die-offs of flamingos have occurred on these lakes. More than 50,000 flamingos died in 1993 and 1995, and two more die-offs in the summer of 1999 and early 2000 killed thousands more. There is a real possibility that the massive flocks of these beautiful pink birds, one of the Earth's great wildlife spectacles, might vanish.

Toxic Chemicals: Page 8

Acid rain is another threat posed to lakes, streams and ponds. Large power plants in Europe and the United States and, most recently, in China, which burn fossil fuels such as coal, have affected forests and aquatic systems hundreds and even thousands of miles away from the source of pollution. In the 1970s, tall stacks were mandated as pollution control to dispel soot particles, sulphur dioxide and nitrogen oxides. Rather than control the problem, they merely spread it by dispersing these pollutants vast distances on the wind. The pollutants combine with atmospheric water and fall to the ground hundreds or thousands of miles away as diluted sulphuric and nitric acids. Coal-fired power plants in England and central Europe have poisoned the lakes and rivers of Scandinavia, while plants in the US Midwest and southern Ontario, Canada, have rendered lakes in New England and Quebec lifeless. In Scandinavia, 20,000 lakes are now lifeless as a result of acid rain (Mason and Macdonald 1986), and in northeastern North America, thousands more have become totally barren (Durrell 1986). Acid rain increases acidity in water to levels toxic to many types of wildlife. In lakes with clear water and few nutrients, acid rain can eliminate all life forms. Acid rain's effects on aquatic species have been catastrophic, eliminating water birds, salamanders, otters, many types of fish, frogs and other temperate wildlife in entire regions.

Coal mines contribute to acidification of aquatic ecosystems as well by exuding acids that poison streams and rivers in their drainage. Thousands of streams in Appalachia in eastern North America have been rendered sterile from coal mines that continue to poison waterways, even when no longer being mined, until they are sealed off. In October 2000, a coal mine sludge retention pond in eastern Kentucky gave way, spilling 200 million gallons of toxic waste into streams feeding the Ohio River (NYT 2000). The state's governor declared a state of emergency in the northeast as water supplies for the entire region were threatened with contamination (NYT 2000).

Toxic Chemicals: Page 9

Air pollution regulations in the 1980s and 1990s mandated removal of the majority of sulphur dioxides prior to the release of emissions, and this has made a difference in the rate of acidification in North America and Europe. In parts of Europe, lime has been broadcast from small planes on some of these lifeless lakes to lower acidity. Usually, liming has to be frequently repeated and is not always effective. When pollution is decreased, however, life forms return, and air pollution controls have resulted in decreased acidification in some areas.

Dioxin, a chemical emitted by paper and plastic manufacturing plants and incinerators, has been found in aquatic ecosystems. It is toxic to many fish and their eggs, and is considered a cancer risk to humans. Dioxin residues in Lake Ontario, Canada, began killing the eggs of Lake Trout as early as the 1940s, and the species became extinct in the lake by the early 1950s (Colborn *et al*. 1996). Dioxin has been found in high concentrations in Eskimos of the Canadian arctic who eat caribou and seal meat; the latter animals consumed dioxins contained in their food from airborne dioxin generated by incinerators in the United States and Mexico (Hilts 2000).

Toxic Chemicals: Page 10

Chesapeake Bay is the largest expanse of saltwater estuary in the United States. Covering 64,000 square miles, its marshes are watered by its major feeders, the Potomac, Susquehanna, Rappahannock and Patuxent Rivers, along with countless smaller feeder streams from its Maryland and Virginia shores. More than 150 rivers and streams contribute to its 650-mile-wide watershed, which extends over portions of six states (White 1982). The Bay is bordered by 8,100 miles of shoreline, including its tributaries (White 1982). The growth of Washington, D.C. and Baltimore and Annapolis, Maryland, as well as other large cities and suburbs on Chesapeake Bay, and the growth of agriculture that leeches sediments and chemicals, have been responsible for destroying large portions of this great estuary. About 140

square miles of the watershed are built on every year. Urban and suburban growth, agriculture, overfishing and industrialization have all taken a toll on the water quality of Chesapeake Bay. The raising of chickens and hogs in factory farms in the region has increased over the past few decades, producing enormous quantities of fecal material that contaminate rivers and the Bay. During storms, containment ponds have overflowed, pouring pollutants into the waterways which have been implicated in outbreaks of red tide and bacterial disease (Broad 1996). Runoff of pesticides, herbicides, sewage, fertilizer and sedimentation have turned the once clear waters murky in many parts of the Bay. The fragile ecosystem of sea grasses and marshland is damaged.

Fisheries that once produced 28 million pounds of oyster meat and 55 million pounds of blue crab have plummeted. The disappearance of 90 percent of the sea grass from Chesapeake Bay, mainly as a result of chemical pollution and sedimentation, has brought about a crash in blue crab populations, with closures in fishing seasons. Crabs lay eggs and shelter in sea grass. Oyster harvests are now 1 percent of what they were a century ago. Their populations have plummeted, and only with their absence is the role that they play in the health of Chesapeake Bay becoming clear. Originally, the billions of oysters filtered the complete volume of water in the Bay in a three-day period, clarifying the water and removing pollutants (Daily 1997). Their ecological value far outweighed the revenue they produced for fishermen. Overfishing has played a role in the decline of oysters, but the major problem is the disintegration of this once-productive estuary through losses of sea grasses and sedimentation from development and pollution. Another casualty was the Maryland darter (*Etheostoma sellare*), known only from a creek in the northern tributaries of Chesapeake Bay. Not seen for many years, some authorities, including the International Union for the Conservation of Nature (IUCN), consider it extinct (Baillie and Groombridge 1996). The shortnose sturgeon (*Acipenser brevirostrum*) historically ranged throughout the Chesapeake Bay area, where thousands were caught annually. Dams, overfishing and pollution combined to eliminate this sturgeon, and spawning no longer occurs in any of the Chesapeake's feeder rivers. The species is threatened throughout its eastern range and is listed on the Endangered Species Act.

Decades after the Clean Water Act came into effect, the Environmental Protection Agency (EPA) announced in 1996 that only 40 percent of the country's waterways are suitable for swimming or fishing because of pollution from various sources. In 1997, residents of 47 US states were warned by EPA not to eat certain types of freshwater fish after issuance of some 2,200 fish consumption advisories, a new high. These advisories list 45 contaminants in lakes and rivers, including mercury, PCBs, chlordane, dioxin and DDT. In many parts of the United States, well water has been found to be contaminated with pesticides and herbicides. This is especially severe in the farm belt of the Midwest, where the majority of these chemicals are used. According to the EPA, 1.25 billion pounds of weed and pest killers were used throughout the United States in 1995, an all-time high. Pesticide and herbicide runoff from agricultural fields was found in half of more than 500,000 miles of rivers tested by the EPA in 1995. Homeowners pouring these chemicals on their green lawns are also contributing to the contamination of streams, rivers and water supplies. A new contaminant of groundwater is a gasoline additive, methyl tert-butyl ether (MTBE). This chemical was designed to reduce air pollution to allow gasoline to burn more cleanly, but because of leakage from gasoline tanks around the country, it has entered the groundwater in every state and has been detected in 5.4 percent of wells in a US Geological Survey study. Other solvents added to gasoline were found in 47 percent of urban wells and 14 percent of rural wells (Saar 1999). The drinking-water limits set by EPA were exceeded in many of these wells (Saar 1999). This chemical is suspected to be a carcinogen.

Contamination of aquatic ecosystems has occurred throughout the world. It has played a role in endangering one of the world's rarest birds, the crested ibis (*Nipponia nippon*). Unlike any other ibis in appearance, the bird has white or pearl gray plumage, a shaggy mane of feathers and salmon pink tail feathers, which contrast with bare red facial skin and carmine red legs. Only 66 birds remain, up from 22 birds in the early 1990s, with a captive population in two breeding centers of over 100 birds (BI 2000). These elegant birds once ranged from southeast Siberia, Manchuria and China to as far east as Korea and Japan. For centuries they were hunted for their long nuptial plumes, nearly causing their extinction (Schreiber *et al*. 1989). The Japanese population of the crested ibis declined until only the tiny Sado Island held the last population; the eggs and chicks were killed by crows and jays, and the last birds were taken into captivity (Schreiber *et al*. 1989). Extinct in Siberia in 1917 and thought extinct in China by 1958, a pair was found

nesting in Shaanxi Province in central China in 1981. This only remaining breeding population has slowly increased, but with fewer than 100 birds in the wild, it remains endangered (BI 2000).

Toxic Chemicals: Page 11

Crested ibises require large trees for nesting near marshes, and to protect these birds, China enacted emergency regulations prohibiting logging in the area. Their nest is a flimsy stick platform lined with small twigs, leaves and hay, built in tree branches at heights up to 25 meters (Hoyo *et al*. 1992). Hunting has also been banned, and the Chinese government accorded them official protection, but some wintering birds are still shot (BI 2000). These birds declined in Japan as a result of poisoning by mercury pesticides and other agricultural chemicals applied to rice paddies. Their feeding habits make them very susceptible to poisoning from pesticides because chemicals accumulate in the bodies of their aquatic prey of crabs, frogs, small fish, mollusk and insects. For this reason, pesticides have been banned in nearby rice paddies (BI 2000). The drainage of rice fields in the wintering habitat has reduced food supply, and 80 percent of birds found dead in the wild have starved to death (BI 2000).

Gold mining has become a major peril to rivers and aquatic ecosystems. The ore is treated with cyanide or mercury to remove the gold, and the toxic waste is either flushed into waterways or accumulates in holding ponds. Cyanide is one of the most toxic of all compounds, and it has caused irreparable harm to the pristine rivers of New Guinea, South America and other parts of the world. Cyanide spills have caused massive fish kills and river destruction in Guyana (Associated Press 1995). Brazilian gold miners have illegally polluted rivers in tribal reservations in remote Amazonian forests with cyanide, destroying the entire fish and aquatic fauna upon which tribes had depended for thousands of years.

In Papua (formerly known as Irian Jaya), the western portion of the island of New Guinea governed by Indonesia, the Grasberg Mine contains the world's largest known gold deposit, an estimated 22 million ounces (Bryce 1995). This mine sits atop a peak in the Sudirman Mountains, rising nearly 16,400 feet, and provides habitat for many unique species (Whitten and Whitten 1992). The Grasberg Mine has polluted the Aikwa River, which drains the region and flows to the southeastern coast, killing fish (Bryce 1995). The mine also contains 15 billion pounds of copper and 37 million ounces of silver, for a total value of $50 billion (Bryce 1995). These ores are being mined and transported through the world's longest slurry pipeline and down the world's longest single-span cable car track to a massive mill (Whitten and Whitten 1992). The entire mountain has already been stripped, reducing it to terraced ridges, and US-owned Freeport-McMoran Copper and Gold Inc., which owns the mine, plans to drill in 75 more sites (O'Neill 1996). The company has been given access to 9 million acres (1.5 times the size of Vermont) by the Indonesian government (O'Neill 1996). French surveyors are seeking uranium in the Vogelkop, or Bird's Head, Peninsula at the far western end of New Guinea, and Australians are searching for gold in the Korowa region in east-central Papua (O'Neill 1996).

New Guinea's great biological diversity is being threatened by this mining. Beautiful birds of paradise, bowerbirds, tree kangaroos and countless other species, ancient forests and wild rivers are gradually being destroyed by mining. At present, forests cover 85 percent of Papua, and clear, free flowing rivers drain the highlands (O'Neill 1996). Much of Papua is without roads, and many areas remain unexplored. New Guinea's extraordinary birdlife is rich in species, totaling 725, more than in all of North America (Beehler *et al*. 1986). Tim Flannery, an Australian mammalogist, is so concerned about the destruction of this island, and the effect on native peoples, that he dedicated his book on New Guinea's wildlife to Chief Executive Officers of mining companies "in the hope that, through reading it, they will understand a little better the people whose lives they so profoundly change" (Flannery 1998). Flannery discovered an extraordinary black and white species of tree kangaroo (*Dendrolagus mbaiso*) in a forest not far from the mine. The mine owners built a large, dam-like structure to contain the enormous amount of mine tailings, all of which are dumped into the headwaters of the Aikwa River. The sediment builds up and smothers the roots of

trees, causing vast tracts of forest to die and killing fish and mudcrabs along the coast (Flannery 1998). The tailings area will eventually be so large that it will be visible from space, and the mine has encouraged logging and other intrusions into the wilderness (Flannery 1998).

To the northwest, rivers of southern Borneo have been turned into "polluted deserts" by local people in search of gold. They clear away the rainforest, destroying banks with high-powered hoses (Mydans 1997). Mercury is used to extract the gold dust, contaminating the rivers with 100 times acceptable levels (Mydans 1997). These forests are home to endangered Orangutans and hundreds of animals and plants found nowhere else on Earth.
South America's river banks are also being ravaged by miners who use high- pressure water jets to blast apart the riversides, destroying all vegetation and habitat for endangered giant otters and water birds. Venezuela's largest mine, Minerven, near El Callao, dumps cyanide and metal particles into a man-made pond without liners or barriers to prevent seepage. Trees surrounding the pond have died, and the pond's surface has become so spongy and dense that one can walk on it (Schemo 1996a). Cyanide dumped into the waters is killing fish and poisoning manatees and other aquatic life.

Oil Spills

The interdependence of mangroves, sea grass and coral reefs can result in the decline of all three ecosystems when oil spills occur. After a 1986 oil spill on the Panamanian Caribbean coast, even minute effects could be measured because the mangrove ecology of this particular area had been studied in detail by scientists from the Smithsonian Institution since the 1970s. First the spill killed expanses of sea grasses and their root systems, along with 150 acres of mangrove trees and their roots in a thin strip along the coast (Luoma 1993). Following this, the waves were able to loosen and suspend the bottom sediments, and these mixed with oil particles which sank to the sea floor; each rainy season, the oil was stirred up and re-suspended (Luoma 1993). This annual flushing of the oil contaminated the entire ecosystem and gradually killed the coral reef (Luoma 1993). Up to 96 percent of corals on heavily polluted reefs died, and even at depths of 12 meters, 45 percent of corals perished; many of the surviving corals suffered toxic effects, being left with bleached and diseased patches (Wells and Hanna 1992). Effects on fish populations were more gradual, taking three or four years before stocks showed sharp declines as a result of destruction of their eggs. The Smithsonian™s Tropical Research Institute prepared a report on the effects of this spill, concluding that full recovery of the ecosystem might take as long as a century (Luoma 1993).

The worst oil spill in US history occurred on March 24, 1989 in Prince William Sound, Alaska, when the Exxon Valdez, an oil tanker fully loaded with crude oil from the Alaskan Oil Pipeline, foundered on a reef just miles from the port of Valdez. This southern coast teemed with wildlife. Fifty pairs of Bald Eagles nested within the Sound, and 2,500 more lived within the archipelago that extends 900 miles to the southwest. Millions of sea birds and waterfowl in vast colonies nested along the coasts, among them the very rare harlequin duck (*Histrionicus histrionicus*), which had a large breeding population. More than 20 million shore birds and other arctic species pass through the Sound while on migration, and in all, 219 bird species have been recorded in Prince William Sound (Browne 1989). The Exxon spill occurred only two weeks before spring migration.

Sea otters (*Enhydris lutris*) numbered at least 10,000 in Prince William Sound, the largest concentration in the world. Thousands of harbor seals used the islands for feeding and calving. Gray whales fed and migrated through the area, and killer whales had resident pods. Commercial fishermen caught vast catches of salmon, herring and other food fish. The coastline, one of the world's most spectacular, is lined with federal, state and native Alaskan protected lands. Kenai Fjords and Katmai National Parks, Kodiak National Wildlife Refuge and thousands of acres of state and native lands had, until the spill, preserved a magnificent environment almost intact. Rocky beaches alternated with marshes and sheer cliffs studded with sea bird nests.

The Exxon Valdez spilled more than 11 million gallons of crude oil. Almost no action to clean the spill took place for days, due to a lack of preparation on the part of the Exxon Corporation and state authorities, and a lack of agreement about whether to burn off the oil, which the state refused to allow, or to spread chemical dispersants that were feared to cause wildlife mortality. This delay allowed the heavy oil to sink to 90-foot depths and spread hundreds of miles along the coast. By April 10, it covered 3,000 square miles, having spread throughout the region's inlets and coves and southwest 500 miles to Kodiak Island, the haven for the massive Kodiak bear (Ursus arctos middendorffi). The amount of shoreline oiled equaled the distance from Boston to the Chesapeake Bay (Mitchell 1999). Surface oil was 18 inches thick, coating sea birds that landed in it with a lethal film. Many died and sank in open water. By the time the spill ceased spreading, it was found to have fouled 1,500 miles of shorelines and covered 10,000 square miles, an area the size of Vermont (Schneider 1994a).

When cleaning finally began days later, it consisted of high-pressure hosing and wiping rocks. This did not remove the tons of oil that sank deep into the sand, marshes and offshore shellfish beds. Only 15 percent of the oil was recovered through vacuum tubes and booms, while the sunken oil remained a decade later, preventing oxygen in mudflats and wetlands from entering with microorganisms that would break down the oil (Mitchell 1999). The rest has been dispersed by a decade of surf and ocean currents washing it away and has evaporated from the surface.

The toll on wildlife was immediate. Sea birds began washing up on the shore coated with thick oil, some still alive. Sea otters struggled ashore as well, trying to clean their coats while lying on oiled rocks. Crews employed by Exxon picked up dead birds and sea mammals, and by May 12, ABC News reported that 20 tons of dead animals had been collected along 550 miles of soiled beach, of which only two miles had been cleaned. Actual numbers of sea bird mortalities will never be known, but some biologists have estimated that up to 500,000 birds died. Species most affected were common and yellow-billed loons, horned grebes, Pacific cormorants, black-winged and white-winged scoters, common murres, pigeon guillemots and the threatened marbled murrelets (*Brachyramphus marmoratus*). The entire population of common murres in the Barren Islands in Prince William Sound apparently died (Senner 1989), and 40 percent of the region's murres died (Mitchell 1999). Oiled birds and sea otters were brought to special rescue centers, where survival tended to be low.

Sea otters incurred very high mortality and suffered for long periods before they died. Their extremely fine fur collected oil as they swam about the surface, unable to avoid the oil like seals and sea birds who submerged or flew away from the spill. At least 980 carcasses were recovered, but judging from counts carried out during the next few years, almost half the Sound's sea otters died during the spill or from its effects (Schneider 1994). People scouring the beaches for oiled animals often heard the otters before they saw them. The crude oil's toxic chemicals literally destroyed their livers and other internal organs within hours, causing such pain that they screamed as they died. Some were found dead with mouths wide open as if still screaming. An ABC news program filmed several of the otter pups that were rescued, doll-like balls of fluff who spent hours screeching for their dead mothers. Having no thick layer of body fat to keep them warm, sea otters rely on their dense, layered fur which they constantly groom so that it remains waterproof, with a layer of air to insulate against the cold. When they swam into oil, the otters groomed furiously but succeeded only in distributing oil over their bodies and into their gullets (Wheelwright 1994). Their clumped fur let icy water in, and the crude oil burned their stomachs, sometimes causing acute emphysema, with air bubbles bulging out under the skin of the otter's throat in a grisly necklace (Wheelwright 1994). Many succumbed to hypothermia and sank. When the dead otters were autopsied, a majority of females had near-term fetuses the size of plump rabbits; the western Sound where the oil spill occurred was a "female" area, and they outnumbered males in the otter morgue two to one, with more than 60 percent pregnant (Wheelwright 1994).

Of the several hundred sea otters brought to rescue centers, fewer lived than died, and only a tiny percentage of the total oiled animals were rescued. Most of the surviving pregnant females aborted or had stillborn cubs. Carolyn McCollum was one of the hundreds of volunteers who came from all parts of the country, and even from foreign countries, to help care for oiled animals. In an article for *Wildlife Conservation*, she described seeing these otters snuggling with towels, bunching them up for a pillow or using them to groom their faces. These intelligent animals have been documented as tool users: they use rocks as shell-openers when hand-held or as hard surfaces upon which

they bang open shells. Carolyn McCollum (McCollum 1990) took care of one female so ill she was unable to eat, wheezing with emphysema: "I could tell from her abdominal breathing that she was in great pain; her sad eyes followed my movements lethargically and I wished there was something more I could do. About 10:00 p.m. she fell asleep; as I felt her chest to make sure she was still breathing, she pressed my hand to her body with her short forearm and I let her hold it there. Ill and weak, the otters at the center behaved like small babies . . .I held my patient's paw until 4:15 the next morning when she stopped breathing. As the vet came to take her to be autopsied . . . I shuddered to think how many more animals would go through the same ordeal.fl

Long-term damage to Prince William Sound started to become apparent by 1994. Marine ecological systems had suffered serious effects. Some species of water birds, especially harlequin ducks, ceased to reproduce in the Sound (Schneider 1994a). Although salmon catches initially rose in 1990 and 1991, as did herring in 1991 and 1992, the catches later plummeted (Schneider 1994a). In the spring of 1994, Alaska officials closed the Sound's herring fishery because there were too few fish. The herring, which are the keystone species in Prince William Sound, fed on by sea birds, mammals and humans alike, died from disease which manifested in skin lesions, perhaps caused by sub-lethal effects of oil (Mitchell 1999). By 1999, herring had still not recovered, and a population estimated at 120,000 tons prior to the spill fell to 40,000 tons (Mitchell 1999). The oil remaining in the water has apparently affected a variety of wildlife, preventing the recovery of virtually every species except the Bald Eagle (Mitchell 1999). Populations of sea otters, harbor seals, killer whales, pink salmon, herring and many sea birds have not recovered. Harbor seals plummeted from 2,000 to only 900 in the Sound. For seals and other fish-eating marine mammals, there are apparently not enough fish to eat, and recovery of fish populations seems to have been slowed by the remaining oil, which kills young fish even at very low concentrations (Mitchell 1999). Fishermen were awarded $5 billion for their losses by a US District Court in 1994, when a jury decided that the captain of the Exxon Valdez had acted recklessly (Schneider 1994b), but they have yet to be paid by Exxon (Mitchell 1999). This company, now merged with Mobil Oil Company, continues to earn approximately $8 billion per year, yet it refuses to settle this claim, and fishermen now earn only half their pre-spill income.

The spectacular Steller's eider (*Polysticta stelleri*) was once an abundant bird of Alaskan and Russian arctic waters. These striking waterfowl formerly nested on the Alaskan Peninsula and the Yukon Delta to the Canadian border, but in recent years they have disappeared from Alaska except the western Arctic coastal plain. Worldwide, their population has declined 50 percent, and they have been listed on the Endangered Species Act as threatened. The oil from the Exxon Valdez and other spills may have spread throughout the region in miniscule amounts that gradually became lethal to these birds. Other oil spills have occurred in Alaska since 1989, including 100,000 gallons spilled in 1997. Some oil tankers have illegally dumped or spilled oil and oily ballast.

Some good came from this massive oil spill. The state of Alaska purchased 650,000 acres of land within the archipelago for wildlife protection with $900 million from the Exxon settlement. Old-growth forests, providing key habitat for threatened species, have been deeded by native corporations for permanent protection from logging in conservation easements, and 61 trout and salmon spawning streams will be purchased (Mitchell 1999). A fund of $140 million, which began in 1994 from Exxon payments, will be available for spending on research, monitoring, fisheries applications and habitat protection (Mitchell 1999). The corporation that monitors the movements of oil tankers through Prince William Sound has adopted new procedures and equipment for fighting future spills, but only three of 28 tankers that use the Sound have double hulls (Mitchell 1999). Double hulls, or an inner hull protected by an outer one, greatly reduce leakage in a collision. It is estimated that 60 percent or less of its oil would have spilled had the Exxon Valdez been equipped with double hulls (Mitchell 1999).

Other oil spills around the world have involved heavy wildlife mortality as well. Jackass or African penguins (*Spheniscus demersus*) once numbered more than 1 million birds in colonies along the coasts of South Africa and Namibia, but their numbers have been in decline for decades. They have declined to 180,000 birds Œ a result of multiple oil spills, destruction of breeding habitat for extraction of guano, food shortages as a result of overfishing by commercial purse seiners, feral cats on their nesting grounds and disturbance by humans causing them to abandon nests (BI 2000). In June 1994, a large spill near Cape Town killed thousands of these penguins (Associated Press

1994). The species was classified as near-threatened by BirdLife International in 1994 (Collar *et al*. 1994), and it has suffered population declines ever since. In Threatened Birds of the World, BirdLife International classifies the species as vulnerable, a more threatened category that indicates serious decline.

In the summer of 2000, a large oil spill occurred within feet of their prime breeding ground off Cape Town. Professional bird rescue organizations, experts and volunteers from around the world converged on the area within a few days. This was the most massive bird rescue in history and saved the lives of over 38,500 adult penguins by placing all adults that could be caught in a giant warehouse and holding area in Cape Town (Associated Press 2000a). Oiled birds were cleaned and fed, while oil-free birds were held to prevent them from becoming oiled in the spill. Most were caught on land attending to chicks and incubating eggs, as this was the height of the breeding season. More than 19,000 birds were shipped 500 miles up the coast and released (Associated Press 2000a). By the time they returned to Cape Town, a swim that was monitored on the Internet, the spill had been cleaned up. The rescuers claimed the unprecedented survival rate of 90 percent. The unfortunate casualties were abandoned chicks and eggs. In spite of the large numbers of birds saved, the entire generation of young were lost, and an unknown number of oiled adult birds died at sea.

In the Siberian tundra, a delicate frozen ecosystem with a thin layer of soil covering permanently frozen ground, known as permafrost, is extremely vulnerable to damage from oil spills. Oil exploitation over the past few decades has resulted in many spills that permanently scarred the land. The most recent, in the fall of 1994, spilled approximately 33 million gallons of oil, three times the total spilled in Alaska, polluting three major rivers. Long-term effects will not be measured for years, but the immediate effects have been massive fish kills in the Kolva, Pechora and Usa Rivers of the northeast (Filipov 1994).

Large oil spills, however dramatic, do not constitute the majority of oil spilled in oceans. They may make up only about 12 percent (Wells and Hanna 1992). Forty-five percent of the oil that is becoming pervasive in ocean ecosystems comes from the routine flushing of tanks and bilges of ships at sea, and one-third comes from regular leakages at land-based operations such as refineries (Wells and Hanna 1992). Floating tar balls and dissolved light oil continue to cause mortality and ecological damage, destroying the waterproofing of birds' feathers and settling on coral reefs. As marine biologist Dr. Sylvia Earle, former chief scientist of the National Oceanic and Atmospheric Administration (NOAA), noted in *Sea Change: A Message of the Oceans* (1995): "Nets dragged through the sea anywhere are likely to come up clogged with tar balls, beaches in the most remote areas are fringed with an oily scum or lined with sticky gobs of oil; over the surface of much of the ocean a rainbow-hued film glistens with deadly beauty at one time or another." Since 1970, 50 major spills the size of the *Exxon Valdez*'s have happened worldwide (Mitchell 1999).

The ingestion of lethal oil compounds, whether within days or weeks after a spill or from residues remaining years afterward which enter the food chain, is the key cause of mortality for the millions of sea creatures that die in oil spills. Research conducted by Dr. Daniel W. Anderson of the University of California at Davis revealed that only 12 to 15 percent of Brown Pelicans rescued in oil spills survived for two years (Kopytoff 1996). The greater the amount of oil ingested, the higher the death rate.

A remarkable discovery in the late 1990s has yet to be aggressively pursued as a means of cleaning up spilled oil. A barber who watched the news of the Exxon Valdez spill noted that the sea otters died in large numbers as a result of the extreme absorbency of their fur and their ingestion of oil while grooming. He began collecting human hair from his barbershop and testing it for absorption of oil. It proved remarkable in its ability to suck up large amounts of oil when contained in mesh nylon bags, leaving almost no oil in the water. He approached NOAA and showed them his findings. They tested the process and confirmed his results. Although this was widely publicized on television and in newspapers, little has apparently been done to place this very simple, low-tech process into real situations by encouraging oil tankers and land-based oil pollution teams to store large amounts of hair for this purpose. NOAA tests determined that the oil absorbed by the hair could easily be recovered by squeezing the bags into holding tanks.

In the wake of the Exxon Valdez spill, Congress enacted the Oil Pollution Act of 1990, which requires oil tankers operating in US waters to pay large penalties and carry massive insurance liability for spills. Civil penalties range up to $1,000 per barrel discharged. Within a month of the passage of this law, 20 oil companies created two new organizations: the Marine Spill Response Corporation and the Marine Preservation Association (Earle 1995).

The need for such protection from catastrophic spillage has been apparent since the early 1970s when these supertankers began to ply the world's oceans loaded with 200,000 tons of crude oil, built so cheaply they had virtually no protection against splitting apart if they ran aground. The dangers of these ships were dramatically portrayed in the 1974 book, *Supership* (Mostert 1974). More than 25 years of oil spills later, stringent regulations still have not become the rule of the sea. An international agreement requires all oil tankers built after July 1996 to have double hulls, but not all countries are complying. Congress put off the effective date of an amendment requiring replacement of single-hulled ships with environmentally sound double hulls to 2015**,** and even this date may be postponed.

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Extinct Species
The Yangtze River (Baiji) Dolphin

The baiji, a freshwater dolphin species weighing 220 to 355 pounds, was historically found throughout the Yangtze River and its surrounding lakes and tributaries. Like other river dolphins, they had long, narrow beaks and poor vision. Because they lived in extremely muddy waters, baiji relied on echolocation to locate mates and food. This dependence kept the ancient species alive for over 20 million years, but recently, human exploitation took its toll. The last official baiji sighting was in 2004, when only two individuals were observed. Sadly, a 2006 expedition revealed no sightings, and the species was deemed fifunctionally extinct.fl

The exponential growth of the Chinese population posed a variety of threats to the survival of the baiji. In 1975, the species was first listed as a Protected Animal of the First Order by the Chinese government. Chinese officials designated protected areas for the baiji; however, the areas proved insufficient and did not encompass the full length of its habitat. Futile captive breeding efforts were also attempted for years.

In the 1990s, electrofishing killed a large number of the dolphins, and overfishing depleted their prey. Additionally, the lengthy construction of the Three Gorges Dam obstructed natural migration patterns, isolated groups of individuals, and impaired breeding opportunities. Along with this industrialization came more ship traffic, which increased the likelihood of dolphin collisions with boat propellers and ships.

Furthermore, the activity in the river created anthropogenic noise that impeded the baiji™s ability to locate food and mates. Water pollution and entanglement in fishing gear are also blamed for the species™ decline. The baiji, accustomed to a pristine and rich environment, was no match for the increasing pollution and congestion of its home.

While the baiji was listed as an endangered species under the US Endangered Species Act and as a critically endangered species on the IUCN Red List of Threatened Species, it was unable to recover due to a lack of information, growing threats and its small population size. Today, the Yangtze River has lost its top predator, which will have a devastating effect on local ecosystems.

Aquatic Ecosystems

Introduction

The marshes, lakes and seas of the world are host to a great diversity of life. In Asian wetlands, brightly colored storks step through reeds while scanning the shallow water for tiny fish. Marsh deer leap gracefully on their wide hooves through mud and spongy vegetation in Brazil's Pantanal. Great flocks of sandhill cranes darken the skies over North American rivers and bogs, emitting their haunting, hoarse cries as they circle to land. Otters, native to all continents except Australia, cavort on river banks, squealing to one another as they leap into the water. Eurasian and American beavers dam rivers, creating ponds where dragonflies, fish, frogs and aquatic mammals thrive. Papyrus swamps line many great rivers in Africa, home to strange shoebill storks, lechwe antelope, crocodiles and hippopotamuses. These aquatic habitats are a lifeline to hundreds more species of birds and mammals who come to drink and bathe. Freshwater ecosystems occupy a tiny fraction of the Earth's surface, unlike saltwater habitats, which cover three-fourths of the planet. Along tropical coasts, mangroves shelter tiny shrimp, crabs and fish. Manatees glide slowly in these quiet waters. A dazzling array of coral grows in fantastic shapes in tropical waters, inhabited by fish, anemones and starfish in every imaginable color, pattern and shape. Throughout the world's seas, whales, dolphins and seals leap above the waves and communicate with one another in complex musical sounds. Bizarre, deep-sea creatures inhabit sulphur-spewing hot vents or lightless sea floors. Wondrous habitats and their wildlife have undergone massive degradation caused by human activity. Many have disappeared altogether over the past few centuries and an even greater number are being destroyed or are losing many native species.

Benefits of Aquatic Ecosystems

Water, the basis of life on Earth, is the most precious of all natural resources. Freshwater and coastal wetlands cover only about 6 percent of the Earth's surface (Lean and Hinrichsen 1992), but produce three-fourths of the world's

fish. Coastal marshes and mangroves play a major role in supporting diversity in the oceans by serving as spawning grounds and nurseries for two-thirds of the saltwater fish and shellfish caught for commercial purposes worldwide (Lean and Hinrichsen 1992). Wetlands perform a major role in preventing floods by retaining rainwater for slow release during the year and absorbing large amounts of rainfall, runoff and snowmelt. Wetlands also filter out contaminants. Some communities in the United States now construct wetlands for the purpose of filtering treated sewage water.

In a new approach to nature conservation, "Earth's Worth" scientists have begun calculating the dollar values of services performed by nature. Traditional economics value natural ecosystems only by practical use to human economies in short-term projects, such as real estate development or resource extraction. For example, how much a wetland is worth is a reflection of tax assessments, which are based on development possibilities and resale values. A boggy woodland might be appraised at a fairly low rate because it is difficult to develop for housing or other buildings. For this reason, such habitats are often bought at low prices and destroyed by development. By contrast, when one considers the ecological services rendered by that aquatic ecosystem, its values are far greater. It absorbs rainwater, thus preventing floods, provides a nursery area for aquatic wildlife and preserves woodland, which produces oxygen. The clean water supplied worldwide by natural filtration by marshes and mollusks that filter water was estimated by a group of ecologists to be valued at a minimum of $1.7 trillion (Stevens 1997). Estuaries and coastal wetlands are nurseries for multi-billion-dollar fisheries and shell fisheries, while they are also valuable in preventing floods. Yet such wetlands, which are often seen as ideal locations for ports and cities, are routinely filled for development. Scientists at the University of California at Berkeley calculated that the remaining wetlands in that state, 91 percent of which have been destroyed, are worth $10 billion annually in ecosystem services (Williams 1996). These ecosystems are usually considered virtually worthless by developers and industry.

The beautiful salt marshes of Georgia were under threat a few decades ago when it was discovered that large deposits of phosphate, which commercial interests wanted to mine for use as fertilizer, lay beneath them. Dr. Eugene Odum, who founded the science of ecology (Odum 1971) and taught at the University of Georgia, was able to prove to the state legislature that the long-term gain from these marshes as nurseries for the valuable shrimp and fish industries far exceeded the short-term profits that would accrue from permanently destroying them by mining. They received legal protection, an important precedent that recognized the economic value of wetlands. Since then, coastal marshes and other wetlands have attracted millions of tourists who come to see the wildlife and beautiful vistas that these habitats provide. Such visitors provide more income to the localities involved than extraction of minerals or development, since ecotourism is permanent.

The reason coastal wetlands and mangroves provide such important nurseries lies in the supply of nutrients they receive from ocean tides and freshwater runoff and rivers. Delta wetlands are especially rich in these nutrients brought by inland rivers and the tides. These floods bring nitrates, nitrites and minerals that nourish the vegetation of the wetlands. This rich habitat was eloquently described in Rachel Carson's *The Edge of the Sea* (1955). Among the grasses and reeds, microscopic life and invertebrates feed a great diversity of fish, shrimp, crabs, mammals, reptiles, amphibians and birds. Bivalves filter the water of aquatic ecosystems, keeping it clear and free of silt and pollutants. Freshwater marshes, lakes and ponds are breeding areas for crustaceans, mollusks and many vertebrates. Millions of waterfowl breed in the seasonal sloughs and potholes of North America prairies. Temporary wetlands, such as the vernal pools or wet season ponds, provide important habitat and breeding areas for frogs, toads, turtles, birds and a rich variety of invertebrates and plants.

Ancient peatlands and sphagnum bogs can be found on every continent except Antarctica. These wetlands absorb vast amounts of rainwater and store it year-round. Their soils tend to be poor in nutrients, but a wide variety of plant life has adapted to these habitats, from mosses and carnivorous plants such as Venus Flytraps and sundews to sedges and exquisite orchids (Rezendes 1996).

Swamp forests, often lining rivers, were once extensive in many parts of the world, providing habitat for water birds, mammals, amphibians and other wildlife, while preventing floods. In the United States, such forests once

covered the shorelines of the Mississippi River and millions of acres in southern states. Deposits of soil from flooded rivers provide nutrients and anchoring for trees and plants. Most of these swamp forests were cut and replaced with agriculture by settlers, and today the region is plagued by floods.

Migratory aquatic animals need several types of habitats during the year. Salmon live in the open ocean but spawn and die in freshwater streams and rivers where the next generation hatches. Cranes and other water birds feed and breed in both salt and freshwater marshes, while using other types of wetlands during migration. Wetlands and surrounding ecosystems, such as woodlands, interact to provide habitat for many types of wildlife. When trees bordering wetlands are cut, this can adversely affect the water flow and wildlife living in wetlands. Some kinds of toads, for example, need both wetlands, such as ponds or lakes where they lay their eggs, and woodlands, where they seek out damp areas to spend most of the year. Thus, when considering the protection of wetlands, the neighboring environments must also be preserved.

Salt marshes in the tropics produce great quantities of plant matter. A reed marsh can produce many times more vegetation than the most fertile grasslands, and some can out-produce an average American wheat field by eightfold (Lean and Hinrichsen 1992).

Mangroves line almost 75 percent of the world's tropical shores (Mydans 1996). They are important in creating conditions for sea grass and coral reefs that are extremely productive ecosystems. Some 50 species of mangroves and related salt-tolerant trees and shrubs grow in silt-laden coastal waters in tropical latitudes (Ripple 1995). Mangroves are pioneer species Œ they create new land. By setting down shoots into the sand or mud, they gradually trap sediment and create soil. These trees' ability to survive in saltwater allows them to colonize coastal areas where no other type of land tree can live. Anchored by roots in mud, they absorb oxygen through breathing roots that grow in the open air above the mud, enabling them to survive in soils devoid of oxygen.

As they grow, they produce new rootlets at successively higher levels above the high tide level (Collins 1990). Old mangrove trees have huge, above-water roots that form a network of hanging branches, and their trunks grow from the new land created. Their fallen leaves decay and provide food for fish and shrimp. The hanging roots become overgrown with an array of algae, sponges, barnacles and mussels, providing shelter for crabs, fish and shrimp, while the upper branches are used by water birds for perching and nesting. Alligators, crocodiles, manatees, young sea turtles and dolphins find refuge here. Sediments are held in place by mangroves, preventing clouding and silting of waters farther offshore so that dense mats of sea grass can flourish, providing shelter for fish, crabs and other marine life. These, in turn, further stabilize the sediment and allow formation of coral beds in clear water further offshore (Luoma 1993). These three ecosystems--mangroves, sea grass and coral reefs Œ often exist together, each helping create an environment for the other. Mangrove forests also buffer coasts from wave action, preventing inland floods. Bangladesh and other countries that have cut their mangroves have been inundated by disastrous floods, causing great loss of human life and property.

Oceans are vital in recycling important elements that represent the basic building blocks of living organisms: carbon, nitrogen, oxygen, phosphorus and sulphur (Daily 1997). Phytoplankton living in marine environments produces between 33 and 50 percent of the world's oxygen supply while absorbing vast amounts of carbon dioxide (Brown 1994). Oceans are the most important factor affecting the world's weather patterns. In turn, they are affected by changes in world temperatures, such as global warming, which create extreme weather from droughts to torrential rainfalls on land. This vast realm is of vital importance to human survival, yet we are only beginning to learn about its role in preserving life on Earth and its ecology, life forms and ecosystems. We have found an increasing use for many of its species for medicine and industry, and each year, new, useful compounds are isolated from marine animals and plants. Although the biological diversity of the ocean is known to be great, research is poorly funded and lags far behind the research on possible life forms on Mars, for example. The latter project consumes billions of dollars while oceanic creatures are fading into extinction prior even to being named.

Corals are among the oldest ecosystems, with a residence on Earth of at least 450 million years (Wells and Hanna

1992). Many reefs have been growing in the same place for millions of years. Glovers Reef off the Belize coast in the Caribbean rises 6,000 feet from the sea floor and began developing about 20 million years ago (Carter 1997). Coral reefs occur in a band approximately 30 degrees north and 30 degrees south of the Equator. Reefs buffer shorelines from ocean waves and in turn prevent erosion, as well as provide quiet waters for sea grasses to grow closer to shore. These grasses, in turn, are fed on by endangered manatees, sea turtles, fish and shellfish. Species diversity, a key to ecological stability on Earth, is very rich in coral reefs, rivaling that of tropical rainforests (Wells and Hanna 1992). The diversity, beauty and productivity of coral reefs make them vital ecosystems to conserve, yet they are in extreme danger of disappearing within the next century. They are the most endangered aquatic ecosystem on Earth.

Coral reefs cover 360,000 square miles, an area equal to only 0.3 percent of the world's oceans and smaller than British Columbia, yet an estimated 25 percent of the world's marine fish species live here (Chadwick 1999, Zuckoff 2000b). The greatest diversity of coral grows in the Pacific and Indian Oceans, in the Indonesian-Australian region where at least 450 species are found (Doubilet 1999). Corals have evolved into many forms. Among the many forms of coral, brain coral is nearly round, while elkhorn grows great branches, and delicate black coral forms thin strands in deep water. Surrounding most mainland and island masses in these regions, corals also populate shallow areas far offshore, as in the Red Sea. The world's largest coral reef, Australia's Great Barrier Reef, runs for 1,400 miles along the northeastern coast of that continent. Up to 3,000 species of plants and animals inhabit a typical Asian coral reef, and more than 1,000 live in Caribbean reefs (Wells and Hanna 1992). They are an oasis of life in warm waters which, in contrast to cold waters, are often poor in nutrients (Doubilet 1999).

Some coral has been found to be 800 to 1,000 years old, based on annual growth rings (Wells and Hanna 1992). Growing very slowly, often less than 1 inch a year, the coral communities are made up of thousands of individual animals. Hard coral secretes calcium carbonate, a substance that becomes as hard as concrete (Doubilet 1999). When corals die, another generation grows on their skeletons, creating gigantic underwater structures that can grow for millions of years.

About 2,000 species of fish inhabit Southeast Asian reefs, and worldwide, between 4,000 and 5,000 fish species have been found in coral reefs so far (Wells and Hanna 1992), including starfish, sea urchins, sea cucumbers, crustaceans and mollusks in an incredible array of forms and colors, some resembling feathery anemones, others boldly striped to warn of poison. Many squeeze into crevices in the corals, creating a tapestry of textures and hues. On the Great Barrier Reef alone, some 4,000 species of mollusks are found, including sea slugs, clams, snails and hundreds of species of cones, trumpet shells, cowries and scallops (Wells and Hanna 1992).

Coral reefs provide habitat for many endangered species. Sea turtles find food and shelter here. The now endangered Hawksbill Turtle (*Eretmochelys imbricata*) was once commonly seen in coral reefs around the world, feeding on sponges and invertebrates (Wells and Hanna 1992). Large numbers of sea birds live on the fish produced in coral reefs, and many sea birds nest on islands around the world that are surrounded by coral reefs. In recent years, coral reef ecotourism has increased. Tourists now gaze at the reef wonders through glass-bottomed boats and scuba masks, generating a new source of income for many countries. Tourism accounts for 55 percent of the Gross National Product of the Bahamas and is playing an increasingly important role in other tropical countries. Tourism is a major incentive for countries to enact strict legislation protecting their marine environments.

Ocean creatures have proven valuable to medical research, supplying compounds that treat inflammations, asthma, heart disease, tumors, infections, viruses and pain (Chadwick 1999). Sea animals, such as cone shells, sea snakes and stonefish, contain some of the most toxic poisons in nature. Such compounds are offering non-addictive solutions to the treatment of pain and other medical problems. Some chemicals in sponges and sea slugs may be useful as insecticides, and coral itself is being investigated for possible use in bone grafts (Chadwick 1999). Glucosamine, a compound found in the shells of crabs and related animals, has proven to be extremely effective in treating osteoarthritis, controlling both pain and the progression of the disease which destroys cartilage. It seems to be a building block for cartilage and has been used safely in Europe for generations. This nutritional supplement has been tested by the Arthritis Foundation in clinical trials, after which it endorsed the use of Glucosamine for osteoarthritis.

Finding new treatments for disease, and substances that can be used as glues obtained from barnacles, are among other ocean-based useful products. Future discoveries will depend on a healthy ocean that maintains its diversity.

Likewise, other types of sea and coastal ecosystem tourism have prospered in recent years. Whale watching has become a $1 billion industry worldwide, according to a 2000 study by the International Fund for Animal Welfare (BG 2000). At least 87 countries sponsor whale watching trips in 500 communities, allowing 9 million people to view these great mammals in 1998 (BG 2000). Cruises to Alaska, sport fishing, bird watching, hiking and other activities in non-tropical and freshwater destinations have also become far more important sources of income than resource extraction in many areas. The effects of the latter industries, including oil pollution, sedimentation from logging and pollution from mining, have decreased their income potential while destroying these precious ecosystems.

Destruction of Aquatic Ecosystems

As aquatic habitats are destroyed bit by bit, countless creatures and plants disappear. Crystalline bodies of water that furnished ample water to wildlife and people alike only a few centuries ago have become polluted or dried up. Growing human populations and development consume millions of acres of ecologically important coastal marshes and mangrove swamps to make way for airports, urban development, seaports, shrimp farms and resorts. More subtle changes are occurring from ozone depletion, acid rain and global warming caused by chemical pollutants in the atmosphere. These may end in far-reaching ecological changes and extinctions that are only beginning to be chronicled.

Less than 3 percent of the Earth's water is fresh, and two-thirds of it is frozen in glaciers and ice caps. The remaining 0.5 percent is contained in aquifers, rivers, marshes, other wetlands and in the atmosphere (Barlow 1999). Global population growth is expected to outpace freshwater supplies by 56 percent by 2025 unless patterns of use change radically (Barlow 1999). Water use has grown at more than twice the rate of population increase in the 20th century, according to the United Nations (Barlow 1999). Almost 70 percent of the world's population lives in areas bordering bodies of water such as rivers, coastlines and lakes, where civilizations have traditionally arisen (Dugan 1993). The United Nations reports some 80 countries, 40 percent of the world's population, are already facing water shortages (Lewis 1996). At least 20 percent of the world's peoples do not have clean water for drinking, according to a 1997 conference of Earth Summit Plus (Grossfeld 1997). Cities have been increasing in size, and the United Nations predicts that within a decade, most of the world's peoples will live in cities for the first time in the human history. Currently, 2.6 billion people live in urban areas; this total is expected to rise to 3.3 billion by 2005 (Lynch 1996). By 2025, 5 billion people, or almost all people now living on Earth, are expected to be city-dwellers, the vast majority in poor countries without effective pollution control or sufficient water supply, by UN estimates.

The United Nations believes that by 2025, the world's population will number 8.3 billion, with two-thirds living in conditions of serious water shortage and one-third suffering from severe water scarcity (Barlow 1999). Growing urban populations require more and more fresh water. Rivers and lakes have been dammed, diverted and channeled to supply these cities, often with disastrous consequences for wildlife. Since all portions of a river are part of the same ecosystem, when it is dammed or altered, the river and its wildlife and plants are affected throughout its length, which may extend over 1,000 miles. Wetlands at the mouth of a river can be drained by the construction of a dam hundreds of miles inland. Likewise, channeling at the mouth of a river, increasing flow for ship navigation, can drain wetlands and alter flow for the entire length of the river, eliminating native wildlife and plants. The Missouri River, for example, was once a shallow, sandy-bottomed river lined with trees and swamps. When Lewis and Clark explored the region in the early 19th century, they saw great numbers of sturgeon, trout and other fish, aquatic mammals, and vast flocks of cranes, waterfowl and shorebirds. During the 20th century, multiple dams were built, and the river was channeled to accommodate ship traffic, radically altering the Missouri's ecosystem. The shallow-water feeding grounds for birds were drowned, and migratory sturgeon and trout found their routes blocked, endangering many

species. After much opposition from barge operators and farmers, Congress funded a program in October 2000 to partially restore the flow to accommodate the needs of native wildlife by altering water releases from dams for a few months each year. Many conservationists are working to save even more of this original ecosystem.

Underground aquifers contain water that has been accumulating for thousands of years**.** Only in recent decades have they been exploited, and many are being over-pumped for city water supplies or agriculture. The High Plains Ogallala aquifer in the Great Plains of the United States stretches from South Dakota to Texas; pumping is depleting it eight times faster than it can be replenished naturally (Barlow 1999). This story is being repeated around the world, especially in desert regions such as North Africa, northern China and the Saudi Arabian peninsula, where fossil aquifers are being over-pumped for agriculture, industry and household use (Barlow 1999). This is resulting in their gradual depletion, contributing to a future "water bankruptcy" (Barlow 1999). Countries in arid regions are already competing for scarce water supplies. The Euphrates River has been dammed by Turkey, turning its flow to a trickle by the time it reaches Iraq. The latter country has become increasingly arid over the past few thousand years as grassland and bountiful water supplies deteriorated to desert as a result of over-use of water and drainage of wetlands.

Trade treaties, such as the North American Free Trade Agreement (NAFTA) signed between the United States, Canada and Mexico and the World Trade Organization (WTO), whose members include the majority of countries, override national water rights, assigning them to corporations and other commercial interests. Water is now being bought and sold as a commodity. One large company, the US Global Water Corporation, has signed an agreement with Sitka, Alaska, to transport 18 billion gallons of glacier water per year to China, where it will be bottled and sold (Barlow 1999). A California company was denied the ability to purchase water from British Columbia and, under the principles of NAFTA, sued the government of Canada for $220 million (Barlow 1999). Environmental and species preservation are not considered in these global transactions. By treating water as a commodity to be traded to the highest bidder, ecosystems will be devastated. The International Forum on Globalization of San Francisco outlines many of these issues that point toward future catastrophes for the environment and human society alike in its report, *Blue Gold*. It concludes that only if water is considered to be commonly shared by humans and all species, and water diversion, damming, pollution, sale and bartering are halted, can there be hope for the future (Barlow 1999).

In the United States, only the onset of droughts brings about restrictions on water usage. Agriculture and livestock use an estimated 65 percent of the country's water supplies, households 10 percent and industry 25 percent. Much of the water used for agriculture comes from diverted rivers in irrigation programs which return it to water tables contaminated with large amounts of pesticides, herbicides and artificial fertilizers. An American family of four uses 300 gallons a day, far more than the average in most of the rest of the world. This profligacy has been at the expense of natural ecosystems. As human populations grow, water use will result in ever more strain on water supplies. Cities have sprung up in near-desert regions in the United States, requiring water diversion from other areas. One of the most dramatic examples of this is Los Angeles. The major flows from several rivers and lakes have been diverted to supply the needs of Los Angeles (Reisner 1986). Only with artificial water supplies has this city been able to grow to metropolis size. Its denizens waste their water supply to grow green lawns, and an enormous amount is used by local industry and agriculture. Los Angeles' water has been supplied at the expense of wildlife and plant species native to the diverted and drained water bodies, many of which are now endangered (Reisner 1986). Salmon and other fish have become endangered in the source rivers and lakes used to supply Los Angeles. Las Vegas, Phoenix and other western cities also tap the scarce water resources of the West. The diversion of water from natural rivers and lakes for large cities and massive agriculture projects is destroying aquatic oases in dry areas and drying up entire rivers in deserts, endangering species as diverse as tortoises, Bald Eagles (*Haliaeetus leucocephalus*) and songbirds.

Half of the people in developing countries suffer from illnesses associated with contaminated water, such as chronic diarrhea (Grossfeld 1997), and more than 5 million people, most of them children, die every year from these illnesses (Barlow 1999). Conflicts over water resources between countries and states are increasing, and in the future, wars may be fought over dwindling water supplies.

Although marshes are able to filter limited amounts of nutrient-laden water, raw, untreated sewage dumped into waterways can turn them into fetid, oxygenless mires. Ninety percent of the sewage in the swelling cities of poor countries is untreated, having had none of the solid matter removed, according to the World Resources Institute in Washington, DC. Some rivers, such as the Ganges and Brahmaputra River systems, are so polluted that the native dolphin, the endangered Ganges River Dolphin (*Platanista gangetica*), struggles to survive in the contaminated water. Fish are killed by the pollution, leaving the dolphins without food, and the high bacteria counts may be killing these dolphins directly. The Ganges has become so sewage-laden that it presents major health risks to the people who drink from and bathe in its water. This is especially ironic because this river is a holy river to the millions of Hindus who come to anoint themselves in its water. India has more than 3,000 towns and cities, but only eight of these have sewage treatment plants (Crossette 1996). Even sewage treatment systems can overflow during heavy rains, spilling toxic chemicals and oily runoff from roads, as well as untreated sewage. Since almost half of the world's population lives in cities, this is one of the world's most serious environmental problems.

The failure to conserve forests and vegetation has become a major factor in destroying natural aquatic ecosystems around the world. Besides causing mud slides and floods, the cutting of trees bordering rivers and streams also results in a rise in water temperature that affects the local climate and kills fish eggs and other wildlife. Clear-cut logging also causes siltation of rivers and lakes, smothering fish and wildlife. Salamanders, who require damp, undisturbed forest floors, are often eliminated by clear-cut logging. James Petranka of the University of North Carolina estimates that in the national forests of North Carolina, 14 million salamanders are wiped out every year by clear-cutting (Stolzenburg 1997). Extreme deforestation causes streams, springs, ponds and rivers to dry up and the regional climate to become more arid.

Oceans were once thought resilient to heavy pollution and the dumping of all types of debris. We are learning, however, that the combined effects of overfishing, killing of coral reefs and toxic contamination are turning them into aquatic deserts, according to Dr. Sylvia Earle, an eminent oceanographic scientist, and conservationist-author, Carl Safina (Earle and Henry 1999, Safina 1997). The oceans have also become crowded with commercial ships, fishing boats and pleasure craft, all of which are causing problems for wildlife. These ships discard plastics and other material and pose a threat of collision. Several cruise lines have been indicted and fined in recent years for dumping illegal materials overboard, including plastics, large amounts of waste oil and other toxic substances.

Coral reefs have proven very delicate and vulnerable to die-offs. Pollution, overfishing, cyanide poisoning and dynamiting to obtain tropical fish for the aquarium and Asian restaurant trades, or corals for the curio trade have all contributed to severe losses in the 70 million square miles of coral reef around the world.

Natural, unpolluted aquatic environments are fast disappearing around the world. Approximately 50 percent of the world's wetlands have been lost in historic times, according to *Wetlands in Danger: A World Conservation Atlas* (Dugan 1993). In the past, wetlands were destroyed primarily for agricultural development. Although this remains a major threat, programs such as dam construction and irrigation projects financed by the World Bank and the International Monetary Fund are becoming the major threat to pristine aquatic environments around the world. Unfortunately, the effects of these losses are usually appreciated too late, when species disappear and water ecologies are damaged.

Soils in many dryland areas have become polluted by salinization caused by irrigation schemes. Irrigation water flowing onto drylands brings to the surface substratum minerals and salts, which render the soil unfit for agriculture or almost any natural vegetation. Regions covering at least 150,000 square miles worldwide have become too saline to farm after irrigation programs (Dugan 1993).

Threatened Species

Approximately 41.4 percent of the 5,435 animals listed by the 2000 IUCN Red List, 2,251 species, are native to aquatic environments. Many more are in lower categories of threat such as near threatened or possibly threatened. Of these, 88 percent are native to inland or freshwater. At least 790 species of fish are threatened with extinction, 627 of these native to freshwater. This is an indication of the effects of dams, pollution and introductions of non-native fish that out-compete native species. Reptiles, totaling 111 species, are threatened by habitat destruction through wetland drainage and pollution, as well as demands of the pet, meat and skin trades that are pushing a growing number of turtles, crocodiles, chameleons and other lizards toward extinction. The threats to amphibians, especially frogs and toads, have grown dramatically in recent years, with environmental factors, such as UV radiation from ozone thinning, pesticide use, wetland destruction and pollution, playing important roles.

(Higher Categories of Threat)

	Marine	Inland Water	Total
Mammals	25	31	56
Birds	105	78	183
Reptiles	9	111	120
Amphibians	0	131	131
Fish	163	627	790
Crustaceans	0	408	408
Insects	0	125	125
Mollusks	13	420	433
Corals & Anemones	2	0	2
Worms	3	0	3
Total Animals	320	1,931	2,251
Plants	0	14	14
Grand Totals	320	1,945	2,265

Based on 2000 IUCN Red List of Threatened Species Compiled by Craig Hilton-Taylor. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland, Cambridge, U.K.

The number of threatened whales, dolphins, porpoises, manatees and seals has greatly increased in recent years. Moreover, many species have been upgraded in status to more endangered categories. Pollution, killing for meat and drowning in fishing nets play roles, but clearly more research needs to be carried out as to whether there is sufficient food for the large whales, such as the Blue, Fin, Sei, Gray and Northern Right Whales, none of which has recovered from past whaling. In the early 1980s, the IUCN, in its various Red Data Books, listed only three species of dolphins and six whales as threatened. In the 2000 IUCN Red List, 25 dolphins, six porpoises and 35 whales are listed in various categories, a dramatic increase. Marine ecological systems are becoming imbalanced as a result of overfishing. Gray whales have been washing ashore dead in unprecedented numbers on the North American Pacific coast. Many are thin and appear to have died of starvation, either from overfishing of their food supply or effects of changes in ocean temperatures brought about by El Nino or La Nina, which can greatly alter the types of fish remaining in an

area. Destruction of sea beds is caused by fishing trawlers who rake sea beds for scallops and groundfish, obliterating entire communities of anemones, starfish, sea grass and habitats for a variety of fish and invertebrates.

A major increase in the number of threatened sea birds has also occurred. The number of threatened albatross has risen from two in the early 1980s to 20 in recent years. Similarly, only two species of penguins were threatened in the early 1980s, while 12 were listed in 2000. Petrels, small nocturnal sea birds that were once abundant, had 12 threatened species in the 1980s, mainly from disturbance of their nesting islands. At present, more than 40 species of petrels and storm-petrels are threatened with extinction. A major cause is long-line fishing for tuna, swordfish and other billfish, with baited hooks that attract albatross and petrels. Sea birds and birds that live along coastlines, lakes and rivers have been endangered by marsh drainage and pollution, human encroachment on their nesting habitats and invasions by exotic species of plants and animals.

The vast majority of threatened fish listed by the IUCN are freshwater species, but this may be an indication of our ignorance about the status of marine fish. The 1990 IUCN Red List included 751 species of fish in various categories (WCMC 1990). That number rose to 979 in 1994 (WCMC 1993), and in the 1996 IUCN Red List, 1,091 species were listed in all categories. The compilers of the 1996 edition of the IUCN Red List noted that only a small portion of the world's fish have been evaluated in terms of their status, and almost no marine species have been researched (Baillie and Groombridge 1996). The 2000 IUCN Red List listed 752 species in its three highest categories, an increase of 18 species from 1996. Worldwide, the status of the majority of fish has not been appraised. Ignorance of marine fish populations has contributed to their depletion in commercial fisheries, which are pushing many species toward extinction (see Trade chapter).

North American freshwater fish are perhaps the best known in terms of the status of the world's fish because of long-term biological studies and the state Natural Heritage Programs, which have a data bank of rare, endemic, declining and imperiled species. Two reports compiled by The Nature Conservancy, 1997 Species Report Card: The State of US Plants and Animals (Stein and Flack 1997) and the book Precious Heritage: The Status of Biodiversity in the United States (Stein et al. 2000), were based on data from the Natural Heritage Programs in all 50 states. The organization found that 16 species of United States fish have become extinct in recent times, and one species is possibly extinct; 93 species are critically imperiled, 88 species are imperiled and 116 are vulnerable. This total of 314 species comprises 36.1 percent of all American fish, which makes for an extremely high rate of endangerment (Stein and Flack 1997).

A major threat to native fish in the United States is the introduction of non-native species, usually game fish such as exotic trout, by state fish departments. Rainbow trout, for example, have been introduced in areas where they are not native, and have out-competed and endangered native cutthroat trout in the West, as well as introduced disease caught in fish hatcheries. Few other countries have undertaken such detailed studies of endangered native wildlife, but in countries where freshwater ecosystems have been greatly altered by channeling, diversion, dams and pollution, research would likely find similar rates of endangerment. In China, 80 percent of major rivers are so degraded they no longer support fish (Barlow 1999).

Frogs and toads represent the most dramatic rise in threatened species of any vertebrate. Their plight may be indicative of the serious environmental threats facing the Earth. Because of their thin, porous skin, frogs are extremely sensitive to environmental contaminants. Within the past few decades, a large number of frog and toad species have disappeared all over the world. Many have been found with grotesque deformities and diseases. What is happening to the frogs appears to be an early warning of serious threats to the Earth's aquatic ecosystems and to its atmosphere. The scale of the recent disappearance of frogs around the world has not been seen since mass extinctions that occurred millions of years ago. The ecological effects will be significant because of their important role in consuming insects and as food items for a large number of animals, from birds to reptiles.

In the 1979 IUCN Red Data Book of Threatened Animals, a world review found 18 species of frogs and toads to be in various categories of peril; in the 1990, the number of threatened frogs and toads had almost doubled to 35, and in

1994, 130 species were listed Œ more than triple the previous total (WCMC 1993). The 141 species in various categories in the 1996 IUCN Red List represented a fourfold increase since 1990 and an almost eightfold increase since 1979. This total grew to 173 frogs and toads in all categories in the 2000 IUCN Red List, with 112 in the three highest categories of threat. Thus, threatened frogs and toads have increased 10 times in number from 1979, a trend not seen in any other large group of vertebrates since such studies began.

The threats to these amphibians are not regional. Frogs are threatened wherever they exist, declining in 140 countries, with status research continuing (Stolzenburg 1997). A worldwide phenomenon is occurring, endangering amphibians and causing extinctions at a spiraling rate. Among the first to disappear were two newly discovered and highly unusual frog species that had been acclaimed as remarkable by scientists around the world. These frogs came from the rainforests of Australia and had astounded the scientific world with their breeding biology. Their life history was so extraordinary that the man who first described it had his paper rejected by a prestigious journal for being implausible. Michael J. Tyler, associate professor of Zoology at the University of Adelaide, discovered these species, known as gastric brooding frogs (Rheobatrachus silus and Rheobatrachus vitellinus), and was beginning research on potential applications of their amazing ability to turn off gastric acids to the treatment of human stomach ailments. These frogs were filmed before their disappearance, which documented that they swallow fertilized eggs that grow in the female's stomach and emerge six weeks later as tiny froglets when she opens her mouth (Yoffe 1992). In 1980, only a few years after their discovery, this species and others in the area vanished; they have not been seen since (Yoffe 1992).

The dazzling golden toad (Bufo periglenes) also disappeared suddenly. Jay M. Savage of the University of Miami came upon this species, native to the cloud forests of Costa Rica, in 1964 in Monteverde Cloud Forest Reserve, witnessing large gatherings of males during the breeding season (Phillips 1994). National Geographic Society filmmakers, in making the film, fiRainforest,fl recorded the assemblages of hundreds of these colorful toads perched on rocks among misty streams, and also filmed their far less flamboyant mates. Less than 2 inches long, male golden toads were bright, shiny orange, in contrast to the slightly larger females who were dark olive to black with spots of red encircled by yellow (Phillips 1994). Depicted on tourist posters and protected in its reserve, the Golden Toad's future seemed assured. No studies were carried out to discover its haunts during the rest of the year, however (Phillips 1994). Tourists flocked to Monteverde, many drawn to see the beautiful toads. In 1987, an American biologist, Martha Crump, witnessed the last breeding group of golden toads. "They've been described as little jewels on the forest floor, and that's really the impression you get," she recalled years later (Phillips 1994). With a grant from the National Geographic Society, she returned in 1988 for two seasons of research (Phillips 1994). In 1988, only 10 toads were seen, and only one male was in the breeding area; in 1989, only one toad was seen (Phillips 1994). None have been seen since (Yoffe 1992); the protected area was enlarged to 26,000 acres in the early 1990s to preserve as much forest as possible.

Two other inhabitants of this cloud forest, a species of translucent glass frog (Yoffe 1992) and an endemic harlequin frog (Stolzenburg 1997) have become very rare. A total of 20 other frog species are also missing from this region, based on a survey of Monteverde by a University of Miami biologist in 1996 (Blakeslee 1997). In Ecuador's high Andes, an estimated 50 species of frogs have disappeared since 1990. In Puerto Rico's rainforests, 12 of 18 endemic frogs are extinct or nearly so (Stolzenburg 1997).

The first World Congress of Herpetology, for the study of reptiles and amphibians, convened in 1989, and many of the 1,300 participants began comparing notes on the shocking fact that the subjects of their research were disappearing from under their very eyes. A comprehensive study was undertaken under the guidance of the IUCN's Declining Amphibian Populations Task Force (DAPTF) (www.open.ac.uk/daptf) to standardize methods of study of amphibian population changes and the environmental factors that may be affecting amphibian reproduction and survival (Stebbins and Cohen 1995). The 1989 conference inspired a symposium the following year that addressed this problem, recruiting 1,000 researchers in 40 countries. The reports from these researchers are published in a bulletin known as the Froglog, published by DAPTF on its website.

What is happening to the world's frogs? Many of the traditional causes still contribute to declines in amphibian populations. Marshlands and boggy areas continue to be filled in and polluted; pesticides, herbicides and other toxic chemicals are entering aquatic ecosystems, causing mortality and mutations. Introduced predatory fish and even exotic frogs have eliminated some frog populations (Yoffe 1992). Trade in frogs for the gourmet food market and for high school biology dissections has also played a role in the declines of some species. Some tropical frogs are known to have succumbed to a protozoan, which kills many and weakens the immune systems of others, making them vulnerable to a host of other pathogens (Blakeslee 1997). The disappearing frogs are not all from polluted areas. Some are native to remote wilderness areas, national parks and other pristine areas. The most surprising possible cause for their disappearance is the increased ultraviolet (UV) radiation resulting from the thinning of the ozone layer. This has been the subject of much research. The thinning of the Earth's ozone layer is caused by Chlorofluorocarbons (CFCs), chemicals used as coolants, aerosol propellants and for other industrial purposes. When released into the atmosphere, they turn into chlorine and destroy the thin-but-vital layer of ozone that shields the Earth from harmful UV radiation. Chlorine-based solvents have also had this effect. First noticed in the 1970s and early 1980s when holes appeared in the ozone layer at the Earth's poles, many years passed until the cause was proven. Those who discovered this phenomenon were awarded the 1995 Nobel Prize in Chemistry, marking the first time this prize was ever awarded for achievement in environmental science. The recipients were Dr. F. Sherwood Rowland of the University of California, Dr. Mario Molina of the Massachusetts Institute of Technology and Dr. Paul Crutzen of the Max Planck Institute for Chemistry in Germany.

Holes and thinning of the protective ozone layer have allowed an increase in the amount of injurious ultraviolet rays reaching the Earth, which has brought about a dramatic rise in the number of human skin cancer cases, as well as declines in amphibian populations. Although the use of CFCs has been banned in new appliances and air conditioners in the United States, the chemical is still used in older cars and refrigerators, escaping to the air from malfunctioning units and improper disposal of these appliances. Illegal CFC imports into the United States have been documented, and some countries still allow their use. CFCs will take at least a century to disappear from the upper atmosphere, according to scientists.

In 1996, Yale University researchers made a discovery that may help stem the breakdown in the ozone layer. A chemical extract obtained from rhubarb and related plants, sodium oxalate, can chemically break down CFCs when heated to 520 degrees F. (Sharkey 1997). The practical use of this discovery is years away, but it may prove to be effective in controlling this lethal phenomenon.

As ancient bridges between land and sea, amphibians were named from the Greek words amphi and bio, meaning living a double life, indicating they were both aquatic and terrestrial. Frogs and salamanders are the only two major groups of amphibians, and they form an evolutionary link between fish and reptiles. First emerging in the Triassic period 200 million years ago, frogs have outlasted dinosaurs, and until recently, most biologists considered them hardy and adaptable species (Yoffe 1992). The vast majority of the approximately 4,100 species live in tropical areas. They must hibernate to survive cold, temperate winters, and relatively few species have evolved this adaptation.

The breeding biology of frogs and toads is a fascinating study in variety. There are frogs that develop marsupial pouches like tiny kangaroos to carry their fertilized eggs, and species in which the males incubate tadpoles in their vocal sacs until they emerge (Stebbins and Cohen 1995). The parent of one tropical frog hops across the forest floor carrying a single tadpole sticking with a mucus to its back; it climbs a tree and steps into a bromeliad plant, placing the tadpole into a tiny amount of water (Roberts 1996). The female returns to lay unfertilized eggs for the tadpoles to eat; she must remember which bromeliads, of the thousands in the area, contain her tadpoles. When the female enters the bromeliad containing her tadpole, it instinctively wriggles, causing vibrations in the water which stimulate the mother to lay eggs for it to eat (Roberts 1996). Wendy Roberts, a biologist who has studied the many reproductive methods used by tropical frogs, believes that as long as frog populations do not continue to disappear, more discoveries of the extraordinary variety of their reproductive biology, parental care and behavior will be made (Roberts 1996). Some toads have even adapted to desert mud holes by burying themselves and entering a torpor-like state until it rains again.

The decline of North America's frogs and toads afflicts fully one-third of the 86 species (Yoffe 1992). Their disappearance in wilderness areas was documented as early as the 1970s. David Bradford, a biologist now with the Environmental Protection Agency, studied the Yosemite toad (Bufo canorus) and Mountain yellow-legged frog (Rana muscosa) in Yosemite National Park in the 1970s at 26 sites. When he returned in 1989 and visited each site, he found frogs had disappeared from all but one site (Yoffe 1992). A 1992 survey concluded that three of the eight toads and frogs native to the Yosemite region have nearly disappeared: the red-legged frog (Rana aurora), which has since been listed on the US Endangered Species Act; the Foothill yellow-legged frog (Rana boylei); and the Great Basin spadefoot (Scaphiopus intermontanus) (Yoon 1996). The Yosemite toad declined or disappeared at nine of the 13 original sites where a 1915 survey had found them abundant (Yoon 1996). Because of the longevity of toads, some living to be 35 years old, declines may go unnoticed as long as adults are alive, even though all their offspring may be dying year after year. Stebbins and Cohen (1995) documented declines in a number of once-common species in their text, A Natural History of Amphibians. Northern leopard frogs (Rana pipiens) and nine other species have become rare or absent in former haunts (Tyning 1995). The latter species has been dissected by the millions in high school biology classes, many of which require the students to kill the frogs, often by cruel means.

Dr. Andrew Blaustein, a herpetologist at Oregon State University, studied the Western toad in lakes in the Cascades Range at 4,000 feet for many years. By the mid-1980s, he found that these toads were becoming rare, yet in the same habitat, Pacific tree frogs (Hyla regilla) seemed to be thriving (Blaustein 1994). Female Western toads produce 12,000 eggs in long strips that are laid in unshaded ponds, and then they disappear into the forest, leaving the eggs to hatch in the shallow water (Blaustein 1994). Dr. Blaustein began to find eggs that did not develop properly, turning white, and then dying and leaving a fetid, viscous mass (Blaustein 1994). Other amphibians of these mountains, the Cascades frog (Rana cascadae) and the red-legged frog, had also disappeared completely from most of their range (Blaustein 1994).

Dr. Blaustein and a colleague decided to conduct outdoor and indoor experiments to test the reactions of frog eggs to ultraviolet radiation. Trays of frog and toad eggs in water were placed outdoors, and some were exposed to UV rays; others screened from UV-B rays, the most harmful type of radiation; still more eggs were brought into the lab and kept in darkened conditions (Blaustein 1994). Ninety percent of the eggs raised indoors, as well as those screened from UV rays outdoors, developed normally, while 40 percent of the unscreened eggs exposed to UV rays died (Blaustein 1994). Here was proof of the effect of present levels of UV rays. Dr. Blaustein and other biologists have concluded acid rain is combining with UV radiation in some areas to kill frogs and toads (Yoon 1996).

Some frogs and toads are dying of unknown causes. One biologist studying the Western toad (Bufo canorus) in a wilderness area in Colorado in the 1970s came upon dozens of dying toads, barely able to move because of their puffy red legs (Yoffe 1992). She took several of them to a veterinarian and was told their immune systems had collapsed, making them vulnerable to infection (Yoffe 1992). Biologists in Massachusetts have found wood frog (Rana sylvatica) tadpoles dying of disease outbreaks in three of four recent years (Knight 1995).

Grotesquely deformed frogs have been discovered recently in many parts of the United States. In 1995, a biology class found frogs with shocking malformations near Henderson, Minn. Some were missing both hind legs; others had as many as six legs, and at least one had an eye growing in its mouth. Another had a leg growing from its stomach. Many had only one leg, one eye, four tangled hind legs, misshapen limbs and tails, missing or shrunken eyes and small sex organs (Associated Press 1996). These deformed frogs were shown on national television news programs throughout the country. Researchers found similar frogs in 1996 and 1997 in California, South Dakota, Wisconsin, Vermont and Massachusetts, as well as in Quebec, Canada. Up to 35 percent of frogs in these areas may be deformed. Within a year, deformed frogs were seen in 54 of 87 counties in Minnesota. A herpetologist from the University of Minnesota at Morris examined 10,000 frogs in the summer of 1996, finding the greatest number of abnormalities in frogs that spent the majority of their lives in water, rather than coming to water only to lay eggs. Vermont's leopard frogs had a 45 percent deformity rate, and for the first time, deformed salamanders were found. Three five-legged salamanders were found in Massachusetts, an ominous sign this phenomenon is spreading to another type of

amphibian.

At the Scripps Institute in California, laboratory tests on frogs produced similar deformities when they were exposed to the commonly used mosquito pesticide, methaprine. This chemical affects growth hormones, causing them to malfunction. In September 1997, officials of the Minnesota Pollution Control Agency announced they reproduced the deformities when frog eggs were raised in tap water from areas with deformed frogs. They issued a public health alert based on this research, providing bottled water to people living in these areas. One Minnesota biologist found internal and external abnormalities in these frogs. EPA studies found deformities when frogs were exposed to ultraviolet rays as well. These findings indicate certain pesticides and UV radiation present major threats to amphibians. Other studies have shown parasites can also cause deformities (Yoon 1999).*

North American researchers have organized the Great Lakes Declining Amphibians Working Group, as well as the North American Amphibian Monitoring Program, maintained by the US Geological Survey of the Department of the Interior. The FROGWATCH USA website gives advice to concerned citizens to learn more about aiding this situation. The US Fish and Wildlife Center provides information about the population status of various amphibians, as does AmphibiaWeb, run by noted herpetologist, Dr. George B. Rabb.

The disappearance of frogs and toads may seem insignificant to many people. From an ecological point of view, however, these animals play an important role in controlling insect populations. After frogs were nearly extinguished in Bangladesh to supply gourmet tables in France with frog legs, mosquito numbers and the incidence of malaria skyrocketed (Yoffe 1992). Frogs themselves are a major food item for a wide variety of animals, from storks to raccoons. They are an important link in the food chain, and their extinctions may have a major effect on a wide variety of other species and even evolution itself (Yoffe 1992).

From a human health point of view, frogs and toads have proven to be the source of many valuable medical compounds. Dart-poison frogs of Central and South America are more terrestrial than species that spend their lives in water, and to protect themselves, they have developed some extremely potent poisons that they excrete through their skin. Natives have used these chemicals on the tips of their arrows for hundreds of years to kill prey as large as monkeys. These tiny, brightly colored frogs are being studied by the National Institutes of Health for the alkaloid compounds found in their skin, which are used in research on nerve and muscle function, and as anti-convulsants and anti-arthritics (Sharp 1995). Another compound found in the skin of an Ecuadorian dart-poison frog has 200 times the pain-killing power of morphine (Sharp 1995).

Preserving Aquatic Ecosystems

Only recently have some aquatic environments received protection in some parts of the world. New marine sanctuaries that protect coral reefs and other sea life have been set aside in a growing number of countries. In 1994, Australia, the United States and six other nations founded the International Coral Reef Initiative to encourage preservation of reefs endangered by pollution, overfishing and other causes. In the future, sanctuaries and international agreements will provide major means of conserving these ecosystems. Unfortunately, many of these sanctuaries allow commercial fishing and the collection of mollusks. The value of aquatic ecosystems in preserving biodiversity is only beginning to be appreciated, aided by the growing popularity of bird-watching, scuba diving and coral reef tourist visits that are educating many people about the importance of protecting these fragile ecosystems.

Private organizations and universities are playing important roles in monitoring and conserving delicate aquatic habitats. The International Marine life Alliance, based in the Philippines, is convincing fishermen to catch fish in hand nets, rather than poison or dynamite reefs. The Global Coral Reef Alliance is investigating diseases that are

afflicting reefs through scientific research, and Greenpeace International has been active in conducting worldwide surveys of the deterioration of coral reefs. Depletion of species by overfishing and consequent imbalances in reef ecosystems and biodiversity are being undertaken in various parts of the world. A Canadian researcher, Amanda Vincent, who documented a dramatic decline in seahorses as a result of over-harvest for Chinese Traditional Medicine, has been working with Philippine fishermen to limit catch and set aside sanctuaries where stocks can increase. Woods Hole and Scripps Oceanographic Institutes are conducting important research in marine environments, studying subjects as diverse as the effects of US Navy sonar testing on whale behavior and deep- sea environments. Small and maneuverable submarines are now exploring deep- sea ecosystems, taking samples of new species and filming these extraordinary habitats. Almost all such research is funded by non-governmental organizations, since governments have yet to realize the importance of funding such research.

International efforts began as early as 1973 to control Marube debris and pollution when the International Maritime Organization, a United Nations agency responsible for shipping, formed an agreement known as MARPOL. This agreement regulated the disposal of oil and hazardous chemicals. In 1978, it was amended to include annexes on the disposal of hazardous materials, sewage, fishing nets, ropes, bags and trash. In 1988, the Marine Plastics Pollution Research and Control Act was enacted by Congress, prohibiting United States ships from dumping plastic items into the sea, and prohibiting foreign ships from disposing of plastics within 200 miles of the United States. Plastics include such items as nylon fishing nets. As of 1994, all US government-owned ships had to comply with all regulations, disposing of plastic waste at port. The National Oceanic and Atmospheric Administration (NOAA) has an interagency task force on marine debris, which has attempted to coordinate other federal agencies to reduce marine debris. The Environmental Protection Agency, with the Center for Marine Conservation, and NOAA coordinate annual beach cleanups, which are now being carried out in some European countries as well as in the Middle Eastern country of Bahrain. Thousands of tons of plastic bags and fishing lines that might have washed back out to sea have been removed by these cleanups. The Marine Entanglement Research Program was established by NOAA in 1984 to study this problem.

As a result of international concern about the disappearance of irreplaceable wetlands, the Ramsar Convention was adopted in 1971. Each member country designates and accords legal protection for at least one wetland to be included in the *List of Wetlands of International Importance*. More than 600 Ramsar sites have been designated, covering 100 million acres. Some of these wetlands, in spite of designation, are threatened by government-sponsored plans. The Acheloos Delta in southwestern Greece may be diverted to produce electricity, and a huge flood-control plan threatens Lake Utonai in Japan. The Ramsar Convention has been instrumental, however, in protecting wetlands through international cooperation. The Wadden Sea, a wetland on the coasts of the Netherlands, Germany and Denmark with up to 12 million birds wintering, breeding or migrating through its land, is being protected through cooperative agreements among the three countries (Dugan 1993). These wetlands are not in their natural state after centuries of diking, filling and other man-made changes, but efforts are being made to maintain large areas of marshland and other wetland habitat.

The North American Wetlands Conservation Act of 1989 created funding to preserve wetlands in Canada, the United States and Mexico; since 1989, hundreds of projects have protected more than 1 million acres of wetland ecosystems in the United States and Canada alone. A prime area preserved by this act is Cheyenne Bottoms, the last sizeable wetland in Kansas, designated as a "Wetland of International Importance" by the Ramsar Convention, a Hemispheric Reserve by the Western Hemisphere Shorebird Network, and Critical Habitat for the endangered whooping crane (*Grus americana*). To date, 6,000 acres have been protected, 35,000 restored and another 13,000 acres of Cheyenne Bottoms enhanced (Graziano 1994).

Another important aquatic environment, the lagoons of Baja California, has been designated a Biosphere Preserve. Under great threat from a proposed salt factory to be constructed by Mitsubishi Corporation in the prime wintering lagoons of gray whales, conservationists succeeded in stopping the project in late 2000. This preserve also shelters sea turtles, many sea birds and other marine mammals. Mexico's laws did not permit such damage to an officially declared Biosphere Preserve, but it nevertheless took years of legal wrangling and the participation of many

conservation organizations to achieve this victory.

National anti-pollution legislation in many countries is making some progress in bringing back rivers and wetlands that had become lifeless from heavy pollution. International treaties have also been negotiated for individual rivers. The Danube River flows 1,770 miles from its source in Germany to the Black Sea, and along its entire length, it has been diked, dammed and channeled to accommodate barge traffic (Cowell 1995). In Hungary, the river inspired the famous waltz of that name and has been severely damaged by dams and diversion on the Slovak side, which have shunted most of the water from one of Europe's wildlife havens. This 200 square mile area is one of Europe's last wetlands, sheltering some 5,000 species of flora and fauna, and Hungary continues to negotiate its return.

The Danube Delta on the Black Sea lies mainly in Romania and is considered one of the world's great wetlands, covering 2,200 square miles (Simons 1997). In the mid-1980s Romania's dictator, Nicolae Ceausescu, decreed that the entire delta be transformed into grain fields (Simons 1997). He succeeded in destroying about one-fourth of the delta, or 240,000 acres, converting the land into wheat and rice fields. Not only was massive wildlife habitat lost, but his men shot pelicans and cormorants because they were eating too many fish (Simons 1997). The drainage plan did not succeed because the delta soil was not conducive to these crops, and by the time Ceausescu was executed by firing squad in 1989, it had been abandoned (Simons 1997).

In 1991 the Danube Delta was declared a Biosphere Preserve, and a conservation plan was set in place; as a first act, dikes and dams were breached, allowing the flooding of more than 9,000 acres (Simons 1997). As a feeding and resting area for millions of migratory birds of 325 species, the delta is of global importance (Simons 1997). It is also a major nesting area for many threatened birds, including the Dalmatian pelican (*Pelecanus crispus*), a bird that was once abundant throughout Western Europe (Hoyo *et al*. 1992). Today, it is confined to eastern Europe and east-central Asia, with approximately 4,000 to 5,000 breeding pairs; fortunately, as a result of strong conservation programs, massive declines have been stopped or slowed (BI 2000).

An ecotourist industry has sprung up in the Danube Delta, helping to fund further restoration (Simons 1997). Anti-pollution work will be needed to cleanse the waters of an overload of contaminants poured into the river by the eight countries through which it flows (Simons 1997). This is the world's first example of the restoration of a delta and is founded on the philosophy that land valuable as flood protection and wildlife conservation is worth more in its natural state than converted for human use (Simons 1997). Experts involved in Mississippi and Rhine River restoration have been interested in the Danube restoration, which may herald a new approach to this crucial habitat.

Sections of rivers have received protection under the Wild and Scenic Rivers Act. This law and the actions private organizations such as American Rivers have succeeded in altering the pro-dam and channeling viewpoint that long has dominated America. The International Rivers Network has also worked to oppose dams around the world, often with great success. On the local scene, River Network, an organization founded in 1988, works at a grassroots level to encourage citizens to help clean up and preserve rivers and watersheds. Its book, *How to Save a River: A Handbook for Citizen Action* (Bolling 1994), provides a blueprint for individual conservationists. The Water Keeper Alliance, first launched to save the Hudson River from heavy pollution, works on many rivers in the United States to test water for pollution and works through activists and lawyers to stop pollution problems (Cronin and Kennedy 1997). Teachers and their students in countless school districts have adopted streams and rivers, removing trash and debris, and restoring them to their original states, even reintroducing native fish.

Progress is also being made in the United States in restoring wetland ecosystems. The Everglades is America's largest wetland. It was a vast, unspoiled marsh, a wilderness of sawgrass, groves of Bald Cypress trees and vegetated hillocks until only a century ago. Fresh water flowed through the 7 million acre Everglades from the enormous, 733 square mile Lake Okeechobee and its feeder rivers to the north, ending in Florida Bay (Levin 1996). During the dry season, rivers threaded their way through the wetland, and in spring wet seasons, the entire region would turn into a shallow river of grass. At one time, more wading birds nested here than anywhere else in the country. Four hundred species of birds, 60 species of amphibians and reptiles, and 25 species of mammals have been recorded in the southern

Everglades alone, and at least 120 species of trees and 1,000 species of seed-bearing plants are native (Rex 1996).

Giant century-old alligators (*Alligator mississippiensis*) prey on a diversity of fish, turtles and snakes. River otters (Lutra canadensis) and tiny white-tailed deer (*Odocoileus virginianus seminola*) are also native. The round-tailed muskrat (*Neofiber alleni*) is found nowhere else. This rodent, dependent on shallow, freshwater marshes, has been affected by the invasion of exotic plants that have taken over much of the Everglades (Layne 1978). The Everglades mink (*Mustela vison evergladensis*) lives south of Lake Okeechobee, far from other races of mink. These animals are aquatic, utilizing much the same type of habitat as the round-tailed muskrat, although they are far more restricted in range (Layne 1978). Both species have declined as a result of development, water pollution and reduction of acreage of the freshwater marshes (Layne 1978).

Settlers arriving in Florida in the 19th century saw only a "pestilence-ridden swamp." The US government drained the entire wetland for development and agriculture, building the first federal canal in 1881 with enthusiastic state support. In 1905, the Governor of Florida vowed to wring the last drop of water out of the Everglades, and state drainage programs supplemented federal projects. Congress passed legislation in 1947 that authorized a massive program to control the flow of the Everglades, ostensibly to prevent flooding; 1,400 miles of canals, dikes and levees were built to straighten and channel the meandering Kissimmee River, the major feeder of Lake Okeechobee, in order to divert water for sugar growers south of the lake (Levin 1996). Four canals drained the lake and lowered water level by 5 feet; 3 to 4 million acres of its water were diverted toward the Atlantic every year, water that once fed the Everglades (Levin 1996). South of the lake, 500,000 acres were drained for agriculture. The same year this project was authorized, a strong-willed newspaper reporter, Marjory Stoneman Douglas (1947), wrote *The Everglades: River of Grass*, pleading for the preservation of this great wetland. She carefully researched the conservation importance of the Everglades and documented the folly of destroying it to appease the growing agriculture industry. The book remains a classic, and not until the 1990s did the country realize that the drainage project was a terrible mistake.

Half the wetlands that once made up the Everglades are gone, now replaced by farms, suburban housing, agriculture and highways (Levin 1996). Ninety percent of the water birds and most of the native mammals have disappeared. The southern Everglades have become increasingly saline from an influx of sea water, causing the disappearance of many species unable to adapt. Some of the overflow from canals during heavy rains has been pumped into the Micaseekee Indian Reservation, which is located in the Everglades, flooding buildings and drowning hundreds of deer. In 1990, outflows drowned 90 percent of the entire deer population in the Everglades. Entire forests of bald cypress trees have died (Dugan 1993).

Wood storks once nested in colonies of 10,000 or more in the swamps northwest of the national park in the Corkscrew Swamp Sanctuary (Toops 1989). This 10,560-acre National Audubon Society sanctuary now protects 400 or fewer pairs of these birds; storks require shallow, freshwater pools that concentrate fish, especially during nesting season, to feed their young. Because of the drainage of the agricultural area and the lowering of water levels, wood storks died out and their chicks starved in the nest (Toops 1989). During the 1930s, at least 75,000 wood storks bred in Florida, but by 1975 there were only 12,000 (Kale 1978). They continued to decline, and in 1980, only 5,000 pairs remained (Lucas 1996). In 1984, the US Fish and Wildlife Service added the US population of wood storks to the Endangered Species Act.

The loss of water in the Everglades has had dramatic effects on alligators. They grow at abnormally slow rates, are underweight for their age and more anemic than alligators in other parts of the South. Research on the diet of these reptiles in 1997 revealed they were malnourished. The once-abundant populations of fish have disappeared, and alligators are forced to scavenge carcasses and feed on small mammals and snakes.

Federal protection was accorded to the southernmost 1.5 million acres of the Everglades by establishment of the Everglades National Park, but its ancient water flow pattern has been so disrupted by channeling, diversion and drainage that the ecosystem is a shadow of its former self. Adjoining the park to the northwest is Big Cypress National Preserve, an area of 570,000 acres also under the jurisdiction of the National Park Service, but with less

restrictions; hunting, fishing and even mining are allowed in National Preserves under certain circumstances.

After 50 years of declining wildlife and proposals to restore the Everglades, Congress passed the Everglades Forever Act of 1994 (Cushman 1996a). Forty miles of the Kissimmee River, whose huge oxbows and curves through marshy pineland were turned into a diked canal by the US Army Corps of Engineers, will be returned to natural bends by this same agency. The cost of repairing the damage is an estimated $500 million, 14 times what it cost to obliterate the river's original curves (Levin 1996). Diking and channeling shortened the river from 103 miles to 56 miles, and a wet prairie where a million ducks wintered was drained (Levin 1996). A recent survey of the area found a total of eight ducks, and droughts in the region have increased (Levin 1996). Some local ranchers oppose the plan, but it has received the support of conservationists and, after intense lobbying, of President Bill Clinton. The nearby National Audubon Society's Kissimmee Prairie Preserve nearby, protects 8,000 acres of the original 30,000-square-mile flood plain of this river (Levin 1996).

Under the 1994 Everglades Forever Act, 40,000 acres of the agricultural lands will also be restored to marsh. A 3-mile-wide flow-way from Lake Okeechobee into the Everglades is another facet of the restoration plan. This would revive marshes below the lake. Sugar farmers have protested government acquisition and resent the proposed controls on the amounts of fertilizers and pesticides that can be released into the water system. The sugar industry in Florida receives $1.4 billion per year in federal tax breaks, and it has balked at any loss in its economic status. Added to the loss of acreage, the industry was angered by a proposed "sugar tax" that would have raised $245 million over a seven years to restore the Everglades (Levin 1996). Political contributions of more than $15 million from the sugar industry to presidential and other politicians™ campaigns to represent their case have stymied efforts to restore this internationally important wetland. The funding was dealt a severe blow in November 1996 when Florida voters rejected the sugar tax plan on the Presidential ballot.

Funding by the Congress, which voted $7.8 billion for the Everglades Restoration Fund in 2000, permitted the project to go forward (Schmitt 2000). Florida will pay half of this sum over the next 40 years to redirect 80 percent of water now diverted back to the Everglades through an untested system of quarries and aquifers, and by removal of dikes and barriers (Schmitt 2000). The plan may not succeed in its goal of restoring the original ecosystem, but water flow will be improved, allowing wildlife to recover some of their populations. In another positive decision, plans that called for turning Homestead Air Force Base at the edge of the Everglades near Miami into an international commercial airport with hotels, development and new roads were canceled in early 2001 by the Clinton Administration (Canedy 2001).

Cleaning up Florida Bay and returning the sea grass to dead areas is another project that began in the 1990s, but it lacks the funding of the Everglades restoration. Its western portion is now saturated with algae, and the native turtle grass has disappeared from large areas (Stevens 1997). The tourist industry centered on snorkeling and diving is in decline as a result. A lack of fresh water has caused increased salinity and a resultant influx of water laden with agricultural chemicals. This aggravates the growth of algal blooms, such as red tide. Endangered sea turtles inhabit Florida Bay, and the coral reefs are home to a great diversity of fish and invertebrates, all of which are in steep decline.

The tourist industry brings $13 billion to Florida each year, a large percentage from Everglades tourists and others who come to appreciate the coral reefs and wildlife. This should impact decisions made to save the Everglades National Park, surrounding wetlands and Florida Bay.

The restoration of the Everglades represents an about-face for the historical approach to wetlands in the United States, and it may be copied in other parts of the country. Wetlands legislation still includes certain concepts such as "mitigation," a legal loophole allowing destruction of one marsh or wetland if another is preserved or created. Many ecologists consider that the natural wetland is far more complex and irreplaceable than the man-made one, and they should not be considered equal under the law (Daily 1997, Williams 1996). These man-made wetlands often fail to function naturally, and the concept of allowing such wetlands to be constructed when natural wetlands are destroyed is

flawed. Developers often construct new wetlands in unnatural blocks without proper natural hydrology or native plants and animals.

Non-governmental organizations, such as The Nature Conservancy and the International Crane Foundation (ICF), have played a significant role in preserving many threatened wetland habitats for birds. The demilitarized zone between North and South Korea is a major refuge for cranes, white-tailed sea eagles and other water birds. Rare white-nape cranes (*Grus vipio*) were discovered feeding in the Han River estuary just south of the zone prior to the diking of these marshes for rice production. Dr. George Archibald, co-founder of ICF, and Korean ornithologist Kim Hon Kyu, convinced the South Korean government to set aside this marsh. Other key wildlife wetlands under threat have been preserved through the diplomacy of these conservation organizations and cooperation between biologists and governments that have bridged old enmities.

The problem of sewage and runoff from roadways, agricultural fields and suburban housing areas will only grow in the future. A US government project to deal with this problem has used natural solutions that could be imitated elsewhere. The project constructed shallow basins to capture runoff that then flows through grass, which removes solids and nutrients, and then to a cattail marsh for further cleansing. The last step is a deep pond with fish and mussels, which filter the water. Ten of these systems have been installed in Maine at a very small cost of $14,000 to $35,000, and similar structures have been built in New Jersey, New York and Massachusetts (Williams 1996). A new treatment process, vermifiltration, in which earthworms in soil filters extract nutrients and suspended matter from sewage, produces an effluent free of pathogens and ideal for irrigation. Several towns and cities in California have created marshes to filter sewage that has been given secondary treatment. These have become wildlife havens and even tourist attractions. By contrast, Boston constructed a 9-mile pipe to carry treated sewage into Cape Cod Bay, where over 300 million gallons will be dumped each day, posing a threat to fisheries and other wildlife. Its cost was $390 million. Some cities have tapped sewage for methane gas to power city facilities.

Scientists are now attempting to address th**e** problem of soil salinization with salt-resistant plants. Department of Agriculture research has also found river reeds that turn toxic chemical runoff into water and carbon dioxide, poplar trees that absorb pollutants from groundwater, and grains and grasses that absorb fertilizer and herbicides, breaking down the toxins (Howe 1997). Prevention and care to avoid such pollution before it happens is even more important for the future.

The facilities for the 2000 Olympic Games at Sydney were designed to be environmentally sensitive. Recycled storm water was used for toilet flushing, and sewage effluent was filtered and recycled (Zuckoff 2000a). A degraded creek was restored to its former state, and when the rare Bell frog (*Litoria aurea*), was discovered on the site of the tennis center, special tunnels were built to allow these frogs to move through it unharmed (Zuckoff 2000a). This center did not create oily residue from automobiles on asphalt parking lots because these were the first Olympic Games to ban all internal combustion cars, requiring travel by trains that connected facilities and solar cars built for the games (Zuckoff 2000a).

Conservationists in the future will need to overcome the effects of a global economy spurred by corporate profits and politicians pushing destructive water projects through legislatures, only to repay financial contributions made to their campaigns or political favors done for them. Extraordinary wildlife habitats can be destroyed with the stroke of a pen. The Copper River Delta of Alaska is a large wetland vital to millions of waterfowl, shore birds and marine mammals, but politicians have proposed construction of a road through it for the benefit of loggers who want to remove timber.

With the warming of the global climate, ship traffic through the Arctic Ocean will increase, and the vast river deltas and waterfowl habitat in northern Canada will soon be threatened by oil tankers and construction of gas pipelines and roads. This region is vital habitat for a large percentage of the continent's waterfowl and shore birds, polar bears (*Ursus maritimus*), whales, seals, walrus and fish. Diamond mining and other development are already encroaching on this pristine area.

The extent of our interference with natural ecosystems is undoubtedly adversely affecting evolution. Nature has evolved superb adaptations in aquatic species**,** survivors for millennia within their habitats. We are just beginning to appreciate and understand the great diversity in aquatic ecosystems and the awe-inspiring beauty here. It is vital that this new understanding be used to protect, not destroy.

Rivers: Dams, Canals and Channeling

More than half of all accessible water is diverted for use by humans (Barlow 1999). Large-scale dam projects on major rivers have increased worldwide from 5,000 in 1950 to 38,000 by the end of the 20th century (Barlow 1999). More than 100 major dam projects are planned in West Africa alone, and conservationists predict crashes in fisheries and flood plain crops as a result (Dugan 1993). Many giant dams have ruined wilderness areas in order to produce electricity for which no demand existed. Wild and beautiful rivers in Indonesia, Brazil, India, Zambia and elsewhere have become fetid lakes, with an enormous loss in wildlife and plants. Many of the tributaries of the Amazon, the world's largest river and home to the greatest diversity of freshwater fish in the world, have been dammed over the past 50 years. In the process, hundreds of species of plants became extinct, drowned by the dam's rising waters.

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Between 1973 and 1983, Brazil borrowed $30 billion Brazil from international funds, such as the World Bank, to construct these dams (Lanz 1995). Huge debts are incurred by poor countries borrowing money from international funds to pay for dams. The real profits from dams accrue to companies that construct them and industries that directly benefit (Lanz 1995). Yet the rationale for dams has traditionally been to benefit the population as a whole. Numerous extinctions of native wildlife and plants have resulted from dam construction. This makes the real cost of such cheap electricity far more expensive, yet such calculations are not considered when nations endorse dams.

Until the 20th century, all but a few of the world's major rivers were pure. Today, the opposite is true. Unpolluted, un-dammed rivers are the exception, and even the great diversity of the mighty Amazon River is now threatened by dam construction on its tributaries. These dams have endangered countless species of wildlife. The majority of species evolved to live in rivers are unable to adapt to conditions created by artificial barriers such as dams and resultant changes in water temperature and current. In the United States, only 2 percent of rivers remain free-flowing and undeveloped (Barlow 1999). All major European rivers have been dammed, diked or channeled. After dam construction, reservoirs, which often cover hundreds of square miles, gradually fill, drowning untold thousands of animals in the process. Even those able to swim to dry land rarely survive because territories are already occupied by members of their own species. In tropical forests, threatened monkeys, armadillos, rodents, snakes and other animals drown, and rare plants and trees die under hundreds of feet of water. Dam gates cause wildlife mortality as well. Endangered West African manatees (*Trichechus senegalensis*) have been crushed to death when caught in the giant gates of these dams, or left high and dry when water levels were lowered (Reynolds and Odell 1991).

Dams upriver from coastal marshes disrupt the flow of water, which can cause crashes in breeding fish populations. Dammed rivers that empty into coastal deltas experience reduced freshwater flow, which creates an

influx of saltwater into freshwater marshes (Lanz 1995). This devastates fisheries adapted to low salinity, such as many species of shrimp and crayfish. An extreme case is in Louisiana; its entire marsh coastline and its $700 million-per-year fishery-based economy have collapsed over the past few decades as saltwater has crept into freshwater marshes, drowning 1 million acres a year. Dikes and levees built for shipping traffic on the Mississippi River and its tributaries have decreased the freshwater flow into the marshes, causing this disaster. Another negative effect of dams on coastal ecosystems is the blockage of silt and sand that enriches delta marshes and maintains sandy beaches. Dams generally have to be abandoned within about 50 years because they fill up with silt and can no longer function efficiently. The serious environmental damage caused far outweighs these short-term economic benefits.

Migratory fish, from salmon to sturgeon and shad, find their paths blocked by dams. They leap in vain at the concrete barriers, and most fail to negotiate fish ladders on those dams that have installed these devices. The young of salmon that manage to hatch upstream from dams are crushed and torn to bits in the dams' massive turbines, which kill 90 percent of salmon young each year in the Pacific Northwest of the United States. Virtually every species of the seven salmon native to this region is threatened with extinction, and 214 stocks are threatened; 106 populations have already disappeared (Stein *et al*. 2000). These salmon and steelhead trout have also suffered from siltation caused by logging and agriculture, which has clouded the clear streams needed for spawning. The loss of these salmon, which numbered in the billions when Lewis and Clark entered the region in the early 19th century, has affected the livelihoods of hundreds of fishermen and wildlife that depended on these fish. Bald eagles, black and grizzly bears, river otters and many bird species rely on these fish as a vital food resource. Each fall, bears eat large quantities of fish, especially fatty fish like salmon, to fatten up prior to their winter hibernations. Without these fatty stores, many bears do not survive the winter.

The outflow from dams is regulated by opening of gates, resulting in flows ranging from trickles to torrents. Wildlife requiring a certain water level can be eliminated when it changes radically. Rare trumpeter swans (*Cygnus buccinator*) wintering in eastern Idaho died in large numbers in 1989 when the reservoir on the Henry's Fork tributary of the Snake River was closed during a drought. The water downstream had previously remained unfrozen in winter, providing vital habitat. In February 1989 when the water froze as much as 4 feet below the surface, more than 50 swans froze or starved. The surrounding community became so concerned they raised $30,000 to purchase 4 billion gallons of reservoir water to be released. *Life* magazine photographer Glenn Oakley documented locals picking up and carrying the surviving swans to indoor areas; some were even warmed in nearby bathtubs. These swans were then transferred to a rehabilitation center where they were kept throughout the rest of the winter, and grain was supplied to the weakened swans remaining in the wild (Life April, 1989). In the words of a rescue coordinator from the Idaho Department of Fish and Game, "I guess nobody ever told these swans they should have filed for water rights."

Even more tragic events took place in Canada, where a massive dam project has inundated some 4,000 square miles of forest land and riverine habitat in Quebec and Labrador. These dams have had major effects on both people and wildlife since the 1970s. They impeded the ancestral migration route of caribou and caused 10,000 of these animals to drown in a torrent of water from one of the new dams in 1990 (Verhovek 1992). Chief Matthew Coon-Come of the Grand Council of the Crees appealed to conservationists to assist tribes in stopping any further work on the dam system. "For 5,000 years we did not leave a trace of our having been in James Bay. What we had came from the land and went back to the land. The land is sacred to us. This land holds the graves of our ancestors. But now, Hydro-Quebec is destroying our sacred land and our way of life. If you were to fly with me today in a Cessna, starting from the first James Bay dam, we'd fly for four and a half hours, and all you'd see is land drowned by water, three major rivers destroyed" (Coon-Come 1993). Chief Coon-Come first began fighting the dam projects in 1972 when he was 16 years old, and in 1994, at the age of 38, he was honored as the first North American recipient of a Goldman Environmental for his achievements in stopping the second phase of the James Bay project.

The Indus River dolphin or Susu (*Platanista minor*) of Pakistan and the Ganges dolphin, which also inhabits the Brahmaputra River system, are highly endangered. These dolphins appear to be blind, but have deeply set eyes that can receive light at an angle, perhaps when they surface (Nowak 1999). Of the two, the Indus River species is more endangered and considered to be on the brink of extinction (Leatherwood and Reeves 1983). It is considered

endangered. This dolphin's entire range lies within the Pakistani provinces of Sind and Punjab where, despite of legal protection, it has declined, mainly as a result of a series of dams on the Indus that isolate populations, along with accidental drowning in fish nets and pollution (NGS 1995). Its population has been estimated at only about 400 animals between two dams in the Sind Province, and perhaps 150 more in small subpopulations farther north in the Punjab Province (Nowak 1999). The Ganges River dolphin inhabits a larger range and is found in western India, Bangladesh and Nepal. Pollution, boat traffic, fragmentation of populations by dams, accidental capture in fishing gear and hunting all threaten this species (Nowak 1999). 4,000 to 5,000 Ganges dolphins survive, and the species has disappeared from the Karnaphuli River to the east of the Ganges at the very least (Nowak 1999). In Nepal, dams have blocked portions of the dolphins™ range, trapping them in portions of river too small to ensure their survival (Leatherwood and Reeves 1983).

Fish and mollusks are especially vulnerable to disappearance when their habitats are radically changed by dams. The conditions created in the reservoir usually end in the destruction of aquatic vegetation, bottom-dwelling mollusk fauna, and the fish, turtles, birds and mammals that are part of free-flowing rivers. Sediment soon covers the mollusks and bottom vegetation and kills them, and water currents no longer bring food to the gills of mollusks and keep water clear. Caddis and stone flies, upon which trout and other fish feed, disappear when their larvae do not hatch in reservoir conditions (Lanz 1995). These insects are the primary food for trout and many other fish. Cold temperatures of swift-flowing, tree-lined rivers in temperate areas that teem with trout and salmon become warm, pond-like areas, to which these species cannot adapt.

Rivers: Dams, Canals and Channeling: Page 2

With a total of 297 species, North America has the world's greatest diversity of freshwater mussels, though they have suffered dramatic declines as a result of dams (Neves 1996). Free-flowing rivers and streams have been turned to ponds, and to compound the damage, the dam builders usually channel rivers downstream. Using machines with revolving chopping blades, natural, curving rivers and streams are converted into straight ditches. Stream edges are cleared of vegetation, and river bottoms are dredged, depositing mollusks and crustaceans in piles along the banks. What is left is a sea of mud in a ditch devoid of life. Malacologist Dr. George M. Davis (1977) concludes these projects, combined with acid drainage from strip mining, erosion and pesticide runoff from agriculture, have been the major causes for the near-extinction of much of the continent's native mollusk fauna (Davis 1977). At least 102 species are considered threatened in the United States, 97 percent of these from habitat loss or degradation (Stein *et al*. 2000).

Prior to the devastation of their habitats, mussels clustered in vast numbers on river bottoms throughout the major rivers and their tributaries in the Midwest and southeastern United States. These rivers meandered through forests that provided cool shade. River otters, muskrats and mink denned among tangled tree roots and in banksides. Water quality remained clear as a result of the forests and the filtering actions of the mussels. River snails fed on the detritus and algae of the mussel shoal, further cleansing the water. The mussel shells formed large, reef-like piles on river bottoms, providing habitat for fish, crayfish, water plants and large river snails. Turtles, aquatic birds and mammals fed on the fish, mussels, snails and crayfish in this ecosystem.

A major center of diversity for these mussels is Alabama, which has more than 235,000 miles of waterways and three major river basins left untouched by Pleistocene glaciers, preserving a great diversity of species (Stein and Flack 1997). Having survived the Ice Age, many species of mussels, fish and crayfish became extinct or endangered when water projects began destroying their habitats in the 1920s. The richest of all known beds, Mussel Shoals, located in the Tennessee River of Alabama, once had a diversity of approximately 70 mussel species. The Wilson Dam, completed in 1924, submerged Mussel Shoals and covered them with 15 to 20 feet of mud, causing the extinction of at least half the mussel species and five of the seven large river snails (Davis 1977). Experts at the University of

Alabama in Tuscaloosa report 69 percent of mussel species are extinct, endangered, threatened or of special concern in the rivers and streams of the state (Cushman 1995b).

Many mussel species need small fish to complete their reproductive cycles. One threatened mollusk, the orange-nacre mucket (*Lampsilis perovalis*) of the Mobile River basin, produces larvae that resemble tiny fish; they anchor to the adult mussel with a long, wavy mucous strand that acts as a lure to tiny fish; when a fish attempts to eat this larva, however, it breaks away and attaches to the fish's body (Hartfield and Butler 1996). The fish carries the mussel larvae to a new area. Other mussels have different reproductive strategies. In some cases, fish congregating around the beds are parasitized by embryonic mussels who cling to their fins or gills and become enclosed in a cyst. The larvae absorb nutrients from the fish for two or three weeks, growing into juvenile mussels, and in the process, they are transported to new areas, where they detach and colonize stream beds (Hartfield and Butler 1996).

The orange-nacre mucket is one of many species that have disappeared from most major rivers, and only small streams and creeks now afford suitable habitats for the creature (Hartfield and Butler 1996). The host species for many mussels are darters. These fish exhibit a rainbow of iridescent hues in a multitude of patterns. Many of their names are evocative of their color or origin: Amber (*Percina antesella*), Bayou (*Etheostoma rubrum*), Goldline (*Percina aurolineata*), Slackwater (*Etheostoma boschungi*), Watercress (*Etheostoma nuchale*) and Okaloosa Darters (*Etheostoma okaloosae*). All the latter species are listed on the Endangered Species Act.

The most famous of these little fish is the 3-inch snail darter (Percina tanasi). Named after the river snails upon which it feeds, this species was discovered on the Little Tennessee River in 1973 above the Tellico Dam site after construction of this major dam by the Tennessee Valley Authority (TVA) had begun. Construction continued after the TVA was able to reverse preliminary injunctions to delay the dam brought by conservationists and irate Tennessee residents being evicted from their land. By the time the snail darter was scientifically described, proposed and listed under the Endangered Species Act, the dam was nearly complete. There is evidence that construction was hastened when word of the fish's discovery became known, in order to prevent conservationists from stopping the dam. The snail darter's survival is due to transplants into other parts of the Little Tennessee River and a few of its tributaries and its discovery in 1980 on a new site in Tennessee™s South Chickamauga Creek, by Dr. David Etnier of the University of Tennessee, who originally discovered the species. The snail darter is now known to exist in Alabama and Georgia, as well as Tennessee. It has been reclassified as threatened under the Endangered Species Act. It does not owe its existence to the TVA, however, which destroyed its only known habitat with a dam, nor to Congress, which rewrote the Endangered Species Act to sanction the extinction of this and other species that might impede "development."

Over three hundred types of crayfish are found in the United States; these species make up 61 percent of the 525 crayfish species found worldwide (Stein *et al*. 2000). Most species live in rivers, streams and waterways in the southeast (Clancy 1997). These crustaceans share many of the same ecosystems inhabited by mussels, darters and snails, and about half the species are threatened with extinction (Stein and Flack 1997). Hiding in crevices, under rocks and buried in sand, crayfish attempt to escape herons, raccoons, river otters and predatory fish (Clancy 1997). A 1996 study by the American Fisheries Society found 65 species of crayfish living in a single river drainage (Clancy 1997). They are usually only 3 or 4 inches long, and like lobsters and shrimp, females carry fertilized eggs attached to the underside of their abdomen. Even after hatching, she allows them to cling to her abdomen for several weeks before they become independent (Clancy 1997).

Native crayfish have declined along with mussels and fish in the altered environments created by dams and channeling. Only four crayfish species out of more than 150 species considered imperiled by The Nature Conservancy are listed on the Endangered Species Act, and almost nothing has been done for their preservation (Clancy 1997). The Nature Conservancy has programs to educate people to protect the land around streams from pollution from cattle, and it is building partnerships with local, rural organizations and conservation groups. The goal of their programs is to preserve the habitats of native crayfish and hundreds of other species by arresting water pollution and other misuses of waterways. This benefits the local economies in the process.

Mussels, crayfish and darters are important indicators of environmental quality because of their great sensitivity to changes in water quality. Scientists have warned a mass extinction of American mussels and crayfish is imminent. Public interest is sparse for these endangered species, lacking the popularity of the bald eagle, the gray wolf or even the black-footed ferret. Yet they are critical to the healthy functioning of southeastern aquatic ecosystems and represent a precious source of diversity on the continent.

The damming of southern rivers continued in the 1960s and 1970s. By 1967, there were nine dams on the Tennessee River, leaving only 22 miles free-flowing. The last un-dammed river in Tennessee, the Duck River, was dammed in 1975. It contained the greatest diversity of snail species left in the Tennessee-Ohio River system (Davis 1977). The Fish and Wildlife Service listed seven species of endangered mollusks native to the Duck River on the Endangered Species Act when the Columbia Dam was under construction. In retaliation, the TVA brought an unsuccessful lawsuit against the Department of the Interior (FWS 1979). Besides the biological impoverishment resulting from destruction of natural rivers and streams, many potential food sources for humans are lost, such as mussels, crayfish and fish.

For fish of rivers in the US West, the opposite conditions prevailed. Flowing through desert landscapes, these rivers tend to be warm and turbid from eroded soil. The Colorado River evolved an extremely rich, endemic fish diversity adapted to this water type. During the 20th century it was dammed throughout its course. Dam operators of the 49 dams on this river occasionally release water from these reservoirs. Coming from the bottom of the reserves, the icy, cold water inundates ecosystems below, creating habitats that endanger native fish. Among these endangered fish are the humpback chub (*Gila cypha*), the Colorado squawfish (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*). The Colorado squawfish, a large fish reaching 6 feet, was once an important food fish for natives and settlers. None of these species have been able to adjust to the cold, clear waters of the dammed Colorado River, which prevented their free movement. The Fish and Wildlife Service has artificially maintained these and other endangered fish in hatcheries, and some populations survive in un-dammed tributaries. Dams on the Colorado River have also inundated precious riverside habitats of small marshes where rare water birds bred. The delta of the Colorado River was once a vast marsh in northern Mexico, a wildlife haven which harbored millions of waterfowl and fish. It was the life blood of the Cocopa tribe. As a result of the dams and diversion of its water to Los Angeles and for local agriculture, the delta is now a mere trickle. The silt that was once deposited on banks and in the delta is now retained upstream, depriving ecosystems downstream of nutrients.

Although the rate at which natural rivers are being dammed has slowed considerably in recent years, for many species the damage has been done. A growing number of organizations and individuals have been urging the removal of dams, especially those causing extinctions. The McPherri Dam on a tributary of the Sacramento River, which once had one of the largest salmon runs in the state, was demolished in 1998, and a few days later, another dam in Medford, Ore., was breached (Egan 1998). A dam on Maine's Kennebec River was removed in 1999, allowing salmon and other fish to return to former haunts. This required the work of many conservationists for more than a decade, and many politicians and others in the state opposed its removal. The 75,000 US dams were often built at huge public expense. Congressional representatives have pushed these projects through Congress for decades, promoted without real analysis of need, economic benefit or environmental effect. Some of the larger dams may be more difficult to remove. The dams on the lower Snake River in the Northwest, for example, have eliminated the millions of salmon that once spawned here, affecting wildlife and local economies. A major effort to breach these dams to allow passage of salmon is gaining momentum, but many barge operators and farmers who transport their grain to market on the barges are strongly opposing the breaching of these dams. In the future, dams may be regarded with less respect as naturally flowing rivers become better appreciated. As former Secretary of the Interior Bruce Babbitt said while commencing the destruction of a dam: "Dams are not like the pyramids of Egypt that stand for eternity. They are instruments that should be judged by the health of the rivers to which they belong" (Egan 1998). Breaching is a compromise to removal of dams that may be more acceptable to dam defenders.

Rivers: Dams, Canals and Channeling: Page 3

The Aral Sea, 300 miles to the east of Siberia's Lake Baikal, is ancient in origin. This was once the fourth-largest lake in the world, covering 25,000 square miles (Kinzer 1997). Two giant dams were constructed in the 1960s on its two feeder tributaries, the Amu Darya and Syr Darya. The diverted water was sent to the south to produce cotton (Filipov 1997). This crop requires great amounts of water and is unsuitable for the arid steppe region. The loss of its feeder rivers caused the Aral to shrink over the next 30 years from 25,675 square miles to 14,090 square miles, and its shores receded up to 50 miles (Stewart 1992). By 1997, it covered only 12,000 square miles, and it continues to shrink (Kinzer 1997). This once rich lake in the midst of the dry plains of Central Asia is expected to completely dry up by 2010 (Filipov 1997). As it dried up, the sediment from the Aral Sea's bed, which contained toxic chemicals, blew away, coating everything within hundreds of miles with 150 million tons of contaminated dust (Filipov 1997).

The wealth of diversity that once teemed in this desert sea has been lost. The destruction of this beautiful lake and its wildlife is without parallel anywhere in the world in recent history, an environmental catastrophe. The water that remains has become increasingly saline and polluted by unregulated industries (Filipov 1997). The collapse of the fishing industry has caused great financial hardship to the people who had lived along the shores of the Aral for centuries. In the 1950s, the Aral produced 40 to 50 tons yearly of sturgeon, pike and roach, among other species of fish; all of its 24 endemic fish are now extinct (Stewart 1992). The mayor of the town of Muynak, located at the southern end of the lake, recalled, "Our fishing boats used to bring in 30,000 tons of fish each year." The town's population dropped from 45,000 in 1967 to 28,000 in the late 1990s (Kinzer 1997).

Of the Aral Sea region's 173 animal species, only 38 survived until the early 1990s (Stewart 1992). Almost all birds disappeared, along with the last of the fish, and only brackish pools remain along the shoreline (Filipov 1997). In March 1991, the Aral Sea was officially declared an ecological disaster area, and the Soviet government appealed to the United Nations Environmental Programme for help; an inter-republic commission was set up to reduce pollution, but with the dissolution of the USSR., the project was abandoned. In the years since the Soviet Union dissolved, destruction has continued unabated (Filipov 1997).

The five newly established Central Asian nations of the region, Kazakhstan, Uzbekistan, Krygyzstan, Tajikistan and Turkmenistan, are now competing for control of the water from its two feeder rivers to maintain their irrigation-fed agriculture (Filipov 1997). Although the leadership of these countries agree urgent action is required to save the Aral Sea, they are not ready to take drastic measures to conserve water (Kinzer 1997). Ironically, much of the diverted water is lost to evaporation and seepage because the irrigation canals were neither covered nor lined (Kinzer 1997). What water is left after heavy application of pesticides and other chemicals sprayed on cotton and rice fields becomes poisoned and trickles into the Aral, further contaminating it (Kinzer 1997). Cancers and other illnesses have struck the local people in Muynak (Kinzer 1997). An environmental organization, Aral-S-O-S, is attempting to reach agreements among the countries, but admits the countries' philosophy of considering water their national property may make the goal unattainable (Kinzer 1997). These nations continued discussions in 2000 without taking any action to prevent the impending loss of the Aral Sea.

In the majority of cases, dams are constructed with little or no knowledge of the ecosystems they are ruining. Likewise, the governments that authorize the dams rarely consider environmentally sound alternatives. In the 1940s, the Volga and Kama Rivers, 300 kilometers north of Moscow, were dammed to form an enormous reservoir that flooded 455,000 hectares (1,124,305 acres) of arable meadowland to produce a relatively small amount of electricity (Lanz 1995). Dams on the Volga impeded the natural migration of sturgeon from the Caspian Sea for their spawning, resulting in a catastrophic decline in the world's most valuable fish. Beluga caviar from the beluga sturgeon (Huso huso), an endangered species, is the most valuable fisheries product in the world, made more valuable by its continued

decline in the Caspian. All the Caspian's species of sturgeon are endangered, as are species of the Amu-Dar and Syr-Dar Rivers feeding the Aral Sea.

The Three Gorges, a Yangtze River Dam project in China that will be completed in the next five years, will be the world's largest hydro-electric project. This dam, expected to cost up to $120 billion, will be 607 feet high, span over a mile and flood 400 miles of this major river, including 30 million acres of cultivated land (Carpenter 2001). The portion of the Yangtze River to be dammed is one of the most picturesque landscapes on Earth, its swift waters flowing through steep gorges and mountains enshrouded in mist. It has been painted by Chinese artists for centuries. The three gorges that will end up under water, the Qutang, Wu and Xiling Gorges, have tributaries and feeder streams that will also be adversely affected. One of these, north of the town of Wushan, the Daning River, is home to many ancient species of trees, such as the Dawn redwood (*Metasequoia glyptostroboides*), the dove tree (*Davidia involucrata*) and various ginkgoes (Hoh 1996). Forty-seven species of rare or endangered plants listed by the Chinese Academy of Science will be inundated when the dam waters rise; among these are many endemic medicinal plants (Hoh 1996). Funds are lacking to treat the 265 billion gallons a year of raw sewage and industrial waste that will flow into the impounded waters from the Three Gorges Dam (Tyler 1996). The project's managers admit there are no immediate solutions to the sewage and pollution problem, or to the impact of huge volumes of sediment that could clog the entire flow of the river (Tyler 1996).

The Yangtze River dolphin (*Lipotes vexillifer*) inhabits this part of the river and faces imminent extinction. Restricted to the Yangtze and portions of the Quiantang River, it has disappeared from much of its original range (Nowak 1999). This dolphin evolved in swift, muddy waters, preferring to live near large eddies. The sonar in its bulbous head is able to locate fish without vision. While this species is actually almost blind, these dolphins have tremendous physical strength to negotiate strong currents. Boat travelers in the river 50 years ago saw hundreds of these dolphins leaping and swimming throughout its length, along with birds and other wildlife. Today, almost no wildlife can be seen. This species was endangered by other dams, collision with boats and ships, dynamiting for channel maintenance, pollution, accidental drowning in fishing nets and loss of food to over-fishing by humans, even prior to the Three Gorges dam construction (Nowak 1999). A large male found dead in January 1996 was examined by scientists; they determined he had died from an electric shock device used to kill fish in the Yangtze River (CNN 1996).

The lakes along the Yangtze once sheltered hundreds of dolphins, but sedimentation from agricultural runoff covered the lake bottom, and sewage polluted the water. It has disappeared from almost all its former strongholds. Surveys in 1986 found 300 animals, but in 1993, 200 or less were estimated to remain, and more recently only 9 individuals could be found (Nowak 1999). This species, adapted for millions of years to life in these rivers is now considered the most endangered of all cetaceans (Nowak 1999). The upper Yangtze will soon be awash in sewage and other pollution from the Three Gorges Dam, which will also block its movements, a habitat where these last dolphins are unlikely to survive. The sole native dolphin in captivity, Chichi, a male, has lived in a small concrete tank at the Institute of Hydrobiology in Wuhan since 1980 when fishermen snagged him on their hooks; he still has scars from these wounds. Pneumonia killed one young female placed with him, and several other females put in his tank in the hopes of captive breeding have died as well, according to a 1999 PBS documentary, "Great Wall Across the Yangtze."

Ocean Park Conservation Foundation in Hong Kong, in cooperation with the IUCN Cetacean Specialist Group and the Institute of Hydrobiology in Wuhan, China, have cooperated in a project to capture as many of the remaining animals as possible before the dam fills and move them to the Shishou Seminatural Reserve (Leatherwood and Genthe 1995). The reserve, a natural oxbow in the Yangtze, also harbors ten finless porpoises (*Neophocaena phocaenoides*) Œ a species that has lived in the river with the dolphins for thousands of years. Finless porpoises are also native to coastal waters west to Saudi Arabia, but their status is not well known. This solution is unlikely to protect more than a few members of the species, and it will almost certainly fade into extinction in the near future. Another species unlikely to survive the effects of this dam is the endemic, migratory Yangtze sturgeon (*Acipenser dabryanus*).

The dam will also affect the Yancheng Marshes, covering some 938 square miles on the north-central coast. Extending for 186 miles, they form a floodplain for the Yangtze River (Simon 1995). Over half a million water birds and shore birds winter here, including the highly endangered red-crowned crane (*Grus japonensis*), whose population in this wetland increased from 200 in 1981 to over 600 in 1987 (Simon 1995). The tidal flats of the Yangcheng are being reclaimed for agriculture, presenting another threat to this species, whose world population totals only about 2,200 birds (BI 2000). Another rare bird, Saunder's gull (*Larus saundersi*), has a world population of only 7,000 birds in decline (BI 2000), breeds in the Yancheng (Simon 1995). This marsh is of great importance to the 226 birds recorded here, since the vast majority of wetlands in China have been drained, polluted or are heavily hunted (Collar *et al*. 1994). For Pere David's deer (*Elaphurus davidianus*), the Yangcheng Marshes are a new home, one of several reintroduction sites for this species that became extinct in the wild and was rescued by captive breeding in England (Simon 1995).

Another water project, said to begin in two years, will divert water from just west of the Yangtze north to Tianjin, a city southeast of Beijing that is suffering water shortages (Eckholm 2000). Should this be carried out, the combined effect of this diversion and the Three Gorges Dam will decrease the flow of the Yangtze River so greatly that these marshes may dry up. Water from the Yangtze River west of the Three Gorges Dam will also be diverted north to the Yellow River, which has been overused and sometimes runs dry, and to mountain zones in the northwest and south (Eckholm 2000). Canals and reservoirs will be dug to carry this water in projects that will cost more than $12 billion (Eckholm 2000). The effects of these diversions on the remaining wildlife of this river will be devastating.

Rivers: Dams, Canals and Channeling: Page 4

Africa's rivers have also been dammed, eliminating wildlife. Most recently, a dam on Tanzania's Lower Kihansi River, costing $272 million, has blocked the flow of a beautiful waterfall, the sole habitat of a newly discovered toad, the Kinhansi spray toad (*Asperginus nectophrynoides*) (Donnelly 2001). This tiny, translucent toad is confined to a 10-acre marsh sprayed by the waterfall. The major source of funds, World Bank, was informed of the imminent extinction of the toad and the loss of the waterfall in 1997, but took no action until Friends of the Earth president Brent Blackwelder wrote the bank's president on the topic of the seriousness of the situation and need for corrective action (Donnelly 2001). An artificial spray system was installed for the toads, and 500 of the estimated 11,000 remaining toads were shipped to the Bronx Zoo and the Detroit Zoo. The toads have proven extremely difficult to maintain in captivity, although breeding did take place at the Bronx Zoo. Tiny, wingless insects must be hand-gathered for these toads, which weigh only two-tenths of a gram, and the majority of the zoo department's staff is occupied in caring for the toads. World Bank employees are considering a $5 million loan to manage the habitat around the Kihansi Gorge to prevent the species from becoming extinct (Donnelly 2001). It is remarkable that the World Bank has been forced to consider the survival of a tiny toad, but unfortunate that the entire ecosystem is being destroyed for electricity production that could have been generated in a less destructive fashion.

The amount of fresh water collected by dams worldwide has increased in the past 40 years by 10,000 cubic kilometers, or 10 trillion tons, an amount equivalent to all the moisture in the Earth's atmosphere (Browne 1996). Much of the water retained in reservoirs is lost to evaporation, especially in arid regions. Geophysicists calculate that dam building will continue until all sources of recoverable water have been exploited, a time that is expected to come in the next century (Browne 1996).

Wetland Drainage

The drainage of wetlands has caused extinctions in some parts of the world. The pink-headed duck (*Rhodonessa*

caryohphyllacea), native to northeastern India, northern Myanmar (Burma) and central Nepal, was locally common during the 19th century in grassy wetlands, where it was heavily hunted by British colonials (Collar *et al*. 1994, Fuller 1987). The male had very unusual coloration, with a bright pink head and brownish plumage marked in pink and white spots. The female was a slightly less colorful version of the male. Males and females uttered different calls, having very different trachea: The male had a two-syllable metallic cry and the female a loud quack (Fuller 1987). Reduced by sport and market hunting, much of its habitat was gradually converted to agriculture, causing an apparent extinction (Fuller 1987). Although not seen in the wild since about 1936, this species is still listed by the IUCN as critical and there is some hope that it survives undetected (BI 2000, Collar *et al*. 1994).

At least five species of frogs have been extinguished by wetlands drainage. The Israel painted frog (*Discoglossus nigriventer*) was last seen in 1940 before its sole habitat, Lake Huleh, was drained for agriculture. Three species of frogs that inhabited the marshes and wetlands surrounding Mexico City disappeared after the city expanded and filled in wetlands for housing and industry and used others for dumping grounds. Leopard frogs of the genus *Rana: Rana johni* and *Rana pueblae* became extinct about 1979, and Tialoc's leopard frog (*Rana tlaloci*) was extinguished in 1990, according to D.M. Hillis, who wrote his Ph.D. Dissertation for the University of Kansas on the species.

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Wetland Drainage: Page 1

South America's Pantanal, the world's largest wetland, is a vast network of tree-lined rivers, lakes, marshes, savannahs, palm groves and hillocks in southwestern Brazil, neighboring Paraguay and Bolivia (Simon 1995). Estimates of its size vary widely. Some are apparently based on the entire floodplain, and others on the wetland's size during the dry season. They range from 39,000 square miles (Dugan 1993) to 77,200 square miles, the size of South Dakota (Eckstrom 1996). By any definition, it is an immense region, having one of the most distinctive mosaics of vegetation and richest wildlife diversity in Latin America (Dugan 1993).* It is highly endangered by water diversion and drainage programs.

The Pantanal forms the upper waters of the Paraguay River system and is fed by the Cuiaba, Taquari and Miranda Rivers (Eckstrom 1996). During the rainy season, from December to June, the Pantanal drains the entire center of southern South America, fed by runoff from Bolivian highlands and the sources of the Paraguay River, forming a vast, shallow lake 7 feet deep with islands of vegetation (Eckstrom 1996). Amazonian fauna and flora meet with those of southern Chaco grasslands and pampas, creating a center of diversity: 3,500 plant species, 102 mammal species, 652 bird species, 177 reptile species, 40 amphibian species, at least 264 fish species and 1,132 butterfly species are native (EI 2001, Schemo 1996b). This huge wilderness is of vital importance to a host of animals that have disappeared from other parts of their ranges. They are threatened by the presence of 8 million cattle and the cattle management, which includes introduction of non-native grasses and clearing forest land monkeys and other terrestrial animals require (EI 2001). A new ecotourism industry is gaining ground in the Pantanal, and is bringing in funds to the region at a time when its natural treasures are most at risk (Schemo 1997).

Marsh deer (*Blastocerus dichotomus*) are South America's largest deer. They are superbly adapted to living in marshes and wet savannah. Their long, coarse coats repel water, and broad, webbed hooves prevent them from sinking into soft ground (Nowak 1999). Leaping over high grass, these deer move swiftly in this watery environment, using the hillocks and islands of vegetation to rest and have their young. Marsh deer formerly lived in the marshes

along the Rio Parana and Rio Paraguay and perhaps as far north as the Amazon River (Nowak 1999). They are gone from Uruguay and have become very rare in Argentina, Bolivia, Peru and Paraguay (Nowak 1999). The Pantanal provides a last retreat for an estimated 7,000 deer, but even here they are declining (Nowak 1999). The species is listed as endangered in the Endangered Species Act, and as vulnerable on the *2000 IUCN Red List*. The estimated five million cattle who graze in the Pantanal (Eckstrom 1996) compete with these deer for habitat and forage. Moreover, cattle have spread brucellosis, which causes reproductive failure, to the deer (Nowak 1999, Thornback and Jenkins 1982). Cattle ranchers have persecuted these deer, and hunting, especially when these deer become stranded on islands during flooding, is another cause of decline (Nowak 1999, Thornback and Jenkins 1982). Dams and drainage for agriculture in the Parana River Delta on Brazil's coast have destroyed much of the once vast marshes there (Thornback and Jenkins 1982).

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*A film that gives an excellent environmental and wildlife portrait of this wetland, fiPantanal: Prairie of the Great Waters,fl was made in 1986 (see Video, Regional, Latin America). It features many of the endangered species described here, along with views of the Pantanal in rainy and dry seasons. A book by Vic Banks (1991), *The Pantanal: Brazil's Forgotten Wilderness*, from the Sierra Club, also gives an overview.

The vast Pantanal is also the most important habitat for the engaging and highly endangered giant otter (*Pteroneura brasiliensis*), which is extinct in most of Brazil and absent from all the larger tributaries of the Amazon (Simon 1995). Killing for otter pelts has been a major factor their decline, and loss of prime habitat is another cause. Degradation of river banks needed for dens by illegal gold miners and cattle, deforestation that affects the water quality and fish with sedimentation and other changes to this wetland have resulted in declines in Giant Otter populations. These otters live in large family groups of up to 20 individuals and require large, high-quality ranges. They are among the noisiest of otter species, uttering a variety of squeals and screams to communicate with one another in the often murky water. This has attracted hunters, who have killed off families and eliminated the species in entire river systems. These otters depend on help from one another, such as loud warning calls about the presence of their major predator, caiman. Their fur is still valuable, although illegal in virtually every market in South America and elsewhere in the world (Nowak 1999).

South America's largest tropical mammal, the South American Tapir (*Tapirus terrestris*), is also native to the Pantanal. Young tapirs have striking white horizontal stripes and spots, which fade into a solid gray as they grow older. Tapirs find the wetlands and abundant vegetation of the Pantanal to be an ideal habitat, and they can be seen swimming in the ponds and bywaters with only their snouts above the water. Like the other three tapir species, the South American tapir has declined throughout its range from hunting and habitat destruction. The IUCN classifies it as near-threatened, and it is listed on the Endangered Species Act.

The Pantanal shelters the largest jaguar population (*Panthera onca*), a threatened species heavily hunted for its pelt and as a trophy. Even in the Pantanal, it was poached until recently, when anti-poaching programs and the Convention on International Trade in Endangered Species (CITES) ban on the sale of spotted cats destroyed the market for pelts and trophies. In this wilderness, jaguars prey on capybara, the world's largest rodent, various deer species and occasionally, domestic cattle. Once heavily persecuted by cattle ranchers, a growing number of cattle ranchers have opened their ranches to ecotourists and now protect jaguars as a prime attraction (Schemo 1997). If there were fewer cattle in the Pantanal, marsh deer, South American tapir and other large mammals would increase, creating a more balanced ecosystem with the jaguar as major predator. This may happen in the future, as the cattle industry is no longer as profitable as it once was (Schemo 1997).

The greatest concentration of water birds in Latin America resides in the Pantanal (Dugan 1993). The jabiru (*Jabiru mycteria*), a large and rare stork, is numerous here, building its great stick nests apart from other water birds.

A colony of wood storks (*Mycteria americana*), a species that is endangered in Florida, may total 20,000 birds in the Pantanal. Egrets, herons and Roseate Spoonbills are abundant. Migrants on their way from southern South America to North America, such as the Arctic Tern (*Sterna paradisaea*), use the Pantanal as an important stopover place (Simon 1995), and three major flyways pass through it (Eckstrom 1996). Snail kites (*Rostrhamus sociabilis*), on the verge of extinction in the Everglades, are abundant here, feeding on the huge apple snails common in the Pantanal. This wetland's palm groves are an important food source and refuge for the largest parrot in the world, the magnificent and endangered blue-violet hyacinth macaw (*Anodorhynchus hyacinthinus*) (Sick 1993).

A zoologically important fish species that has been on Earth for 300 million years is also resident in the Pantanal. The South American lungfish (*Lepidosiren paradoxa*) is a member of a family with only six species remaining, all on other continents. Lungfish can breathe air with their single lung and are thought to be an evolutionary bridge between fish and land animals. At about 32 inches in length, this scaled, eel-like fish breathes at the surface when waters are high, and during the dry season, buries itself in the mud, breathing through a narrow tunnel leading to the surface, or entering a torpor-like state (Dorst 1967). Although not restricted to the Pantanal, this wetland provides ideal habitat for lungfish, and a large population is found here.

The Pantanal is decreasing in size as a result of drainage for agriculture, which has altered the flooding cycle (Dugan 1993). The major threat to this wetland is a 2,000-mile canal for shipping being dredged and channeled from the Paraguay-Parana Rivers, which link below the Pantanal. Five countries, Brazil, Bolivia, Paraguay, Argentina and Uruguay, border these rivers and support this massive program, known as the Hidrovia Project (Schemo 1996b). The canal is intended to open up new markets for a growing agricultural trade for soybeans and sugar, as well as mining products from western Brazil (Brooke 1995). It will extend from Caceres, Brazil to Punta del Este, Uruguay, creating an inland seaport in Bolivia; construction involves blasting through rock formations, straightening and dredging rivers and controlling tributaries to allow year-round shipping (Schemo 1996). Although originally estimated to cost $1 billion, by the time the gates of the Porto Primavera Hydro Dam on the Parana River were closed in November 1998, costs had expanded far beyond the original estimate. At least $3 billion will be required for future maintenance (Eckstrom 1996).

A critic of the Hidrovia Project pointed out that an old railway crossing the southern Pantanal already exists, and new railways could be built to Sao Paulo (Eckstrom 1996). Biologists and ecologists are extremely worried that the basic hydrology of the Pantanal is not sufficiently understood to make such major changes, and the long-term effects of Hidrovia may be totally unforeseen, ending in destroying this wilderness (Eckstrom 1996).

Ignoring the delays imposed for completion of the $10.5 million environmental studies, Paraguay began work blasting through rock on the Paraguay River north of Asuncion in June 1996. The Inter-American Development Bank contributed $7.5 million in 1991 for feasibility studies, but the studies were carried out by the same company performing the engineering work, and they did not appraise the work as a whole. The United Nations Development Programme's ecological advisor on the project, Dr. Enrique Bucher, protested this approach: "In order to understand the hydrological response of the system, you have to analyze it in its globality" (Schemo 1996b). The Hidrovia Project, may result in draining the Pantanal, according to a study by Victor Ponce of San Diego State University (Schemo 1996b, 1997). The Pantanal acts like a vast sponge, releasing rainwater gradually and year-round into the Paraguay River; the dams and drainage of wetlands will expose down-river areas to flash flooding and start drying out this vast marshland (Brooke 1995)

Pantanal wildlife has already been impacted by the Porto Primavera Dam, the first of several dams in the Hidrovia Project, which drowned 300,000 acres of floodplain, forest and grasslands. The dam builders financed "rescue" of animals as the area filled with water in late 1998, filmed for the National Geographic Explorer program ("Paradise Lost," April 28, 1999). This "rescue" was marked by extreme mistreatment of animals and a low survival rate. Black howler monkeys were knocked from tree tops by ramming the tree trunks with motorboats, causing babies to fall off their mothers' backs. Many of the monkeys had just given birth and were separated from family members. Injuries such as broken tails occurred. The monkeys were treated so roughly that they panicked and thrashed about. To

subdue them, they were put in bags for transport. One monkey in a bag was hung over the side of the boat into the water, where it must have drowned during the trip to a holding area. Surviving animals were unceremoniously dumped in enclosures and cages in the holding area. Many of the monkeys, armadillos, opossums, foxes, snakes and other wildlife were crated and transported out of the area for donation to zoos and research institutes. Caiman were also captured, apparently for their hides, since they were not at risk if left in the water. Marsh deer were caught in nets dropped from helicopters, placed in a net and sent by helicopter to their permanent new home in a concrete enclosure. Many died in the process. Only a few of the animals, including some of the monkeys, were released in woodland nearby. The rescuers admitted only about 5 percent of the wildlife was "saved."

Although gold mining has been banned in the Pantanal, illegal mining is fouling the rivers with mercury and other pollutants (EI 2001). Only two small areas in the Pantanal have received official protection (Dugan 1993). The Pantanal National Park protects less than 1 percent of this wetland, covering only 550 square miles, of which 53 square miles are dry land; most of the park has been underwater for the past 20 years (Eckstrom 1996). The Taiama Ecological Station covers 43 square miles (Emory 1990). Thus, well over 90 percent of the Pantanal is privately owned, mainly by cattle ranchers. Whether it will be possible to preserve large portions of the Pantanal remains to be seen. A budding ecotourism industry has begun, but the damage may already be done. By 2010, the Pantanal may have dried out, or its hydrology been so altered that only remnants of this once vast wetland will remain, as occurred in wetlands of the upper Nile River after the building of the Aswan Dam.

A biological diversity survey of the Pantanal is being carried out under the direction of Conservation International, an organization that specializes in such studies, using Brazilian and American scientists and volunteers from Earthwatch Institute, a group that helps fund scientific studies. Many individual projects will be carried out by various Conservation Research Centers, where scientists, educators and conservationists can cooperate to help preserve the Pantanal (EI 2001). One project on a 7,000-hectare ranch will study ecosystem components and create a series of corridors for the future management of the region (EI 2001). Another will study the avian diversity of the Rio Negro region. The fish of the Pantanal, their diversity, ecology and environmental needs, will be the subject of another study (CI 2001). Should the Pantanal begin to die as an ecosystem, a very real possibility in view of its threats, conservationists can use the data that these scientists are compiling of the great wealth of wildlife and plants and how they are affected by the downstream water projects in order to urge protection through alteration or even cancellation of water projects. As the planet's greatest wetland, interest in its conservation reaches around the world, and the better its functioning is understood, the more coherent will be its defense.

Wetland Drainage: Page 3

Africa's two largest wetlands are Botswana's Okavango Delta and the Sudd marshes of southern Sudan. Both are threatened by massive water projects that may result in draining them for agriculture. Civil war in Sudan has so far prevented the construction of the Jonglei Canal, which would drain large sections of the wetland. The Sudd, covering 6,370 square miles when flooded by the Nile, is a maze of lakes, rivers and papyrus swamps among lush grassland and woodland savannahs (Simon 1995). It has the richest diversity of birds of any African wetland. The extraordinary shoebill, or whale-billed stork (*Balaeniceps rex*), the sole member of its avian family, is resident. This stork-like bird, whose scientific name means "whale-headed king," resembles a creature imagined by Dr. Seuss, with an outsized head and huge primitive beak ending in a long hook. The papyrus swamps that are the bird™s habitat are being drained throughout their range, which extends from Sudan south to Zambia. Fires set in the swamp, civil wars and large numbers of cattle tramping vegetation and destroying nests in the Sudd and elsewhere have disrupted protected areas such as the Akagera National Park in Rwanda (BI 2000). Tanzania's population of 2,000 birds is one of the few stable ones, newly protected as the country's first Ramsar site (BI 2000). Large numbers are captured for zoos, which exhibit this bird as a curiosity (Hoyo *et al*. 1992). The total population of this unique species was estimated at about 11,000 to 15,000 birds and declining in the late 1990s (BI 2000).

In the Sudd's floodplains and grassland are enormous herds of two antelope, the kiang, a subspecies of the topi (*Damaliscus lunatus tiang*) and the white-eared kob (*Kobus kob leucotis*). Almost a million of these antelope migrate to take advantage of grassland, forming the second largest aggregation of large mammals remaining in Africa after the wildebeest (*Connochaetes taurinus*) of East Africa. A film about these spectacular animals, fiMysterious Herds of the Sudan: Migration of the White-eared Kobfl (see Video, Mammals), shows this landscape as well, a little-known corner of the Earth whose abundant wildlife may be decimated if the Jonglei Canal is constructed. Another threatened species that is found only in the Sudd and wetlands of adjacent Ethiopia is the Nile lechwe (*Kobus megaceros*), a wetland antelope with elongated hooves that spread the weight of its body to keep it from sinking and help it leap through shallow water in bounds. This black antelope has ridged horns that arch over its back and a goat-like appearance. The *2000 IUCN Red List* lists it as near-threatened. The Nile lechwe's population totals about 30,000, but its range is restricted, and should its habitat be destroyed by water projects, it will be threatened with extinction (Nowak 1999).

In the middle of the vast Kalahari Desert is a brilliant, blue gem, the 11,000-square-mile Okavango Delta wetlands. This extraordinary wildlife oasis is the world's largest inland delta, a magnificent watery wilderness of shallow lakes, papyrus swamps, meandering rivers, wet grasslands and woodlands. World renowned for its large populations of zebra, antelope, African elephant (*Loxodonta africana*) and Cape buffalo (*Syncerus caffer*), the Okavango attract tourists in large numbers. Waterfowl are abundant, and the African fish eagle (*Haliaeetus vocifer*), which resembles the American bald eagle, is common. Fifteen species of marsh-dwelling antelope are native, many of which are unique to this region. One of these, the threatened red lechwe (Kobus leche), has a large portion of its population, some 30,000 animals, in the Okavango (Nowak 1999). A race of this antelope in the wetlands of Zambia, the Kafue lechwe (*Kobus leche kafuensis*), lost half its population of 100,000 in 1970 after the construction of two huge dams for hydroelectric power on the Kafue River, which radically altered the natural flooding and dried out much of its floodplain habitat (Nowak 1999). Another race of this species, *Kobus leche smithemani*, native to the Bangweulu Swamps of northern Zambia, fell from about 250,000 in the 1930s to around 30,000 today, as a result of hunting and disruption of water levels by human manipulation (Nowak 1999). Yet another race, *Kobus leche robertsi*, native to the Luongo and Luena River drainages of northwestern Zambia, is now extinct (Nowak 1999).

Cattle ranches have been carved out of portions of the Okavango, but until recently, this immense swamp remained nearly intact. Its precious water supply is now in decline. A major feeder of this swamp, the Kavango River, is now having much of its flow siphoned off by the Namibian government for agriculture and residential use. Botswana has objected strenuously to this project, but Namibia is determined to ease a severe water shortage caused by years of drought. The Boro River, which emerges from the delta, may be dredged and diverted for diamond mines (Postel 1997). These projects may end in draining the Okavango and destroying the enormously profitable tourist industry in Botswana (Hawker 1997). This wetland receives irregular rain which brings flocks of flamingos to nest and renews the water table, but should its feeder river be blocked, many of its unique wetland animals and sizeable herds of endangered African elephant may be lost.

Another threat to the Okavango Delta is the planned spraying of 7,180 square kilometers with the pesticide endosulphan, beginning in the winter of 2001 (Tyler 2001). The purpose is to destroy tsetse fly, the dreaded vector for sleeping sickness or trypanosomiasis (Tyler 2001). This pesticide is toxic to small fish and many other types of insects that are primary sources in the food chain for aquatic birds, such as herons and egrets. These birds breed during the winter months when the spraying is planned, and the threatened Slaty egret (*Egretta vinaceigula*), which breeds in the delta and has a world population of only 5,000 to 10,000 birds, is at serious risk (Tyler 2001). Ironically, the tsetse flies were being effectively controlled by the use of cloth baits soaked in insecticide and hung on poles, but they were not properly maintained by personnel, and stocks ran out (Tyler 2001). Conservation organizations are protesting to the Botswana government to stop the spraying and consider the environmental effects. Until recently, sleeping sickness was not an easily controlled disease, killing thousands of Africans. Native hoofed animals are immune to the disease. Recently, however, a new drug, DSMO, used in the United States to remove facial hair, has been found to be almost a miracle drug in awakening victims of this disease from their comatose states, without the

side effects of available medications. One pharmaceutical company agreed in early 2001 to donate 3 years™ supply after pressure from various health organizations. This makes spraying toxic pesticides even more unnecessary.*

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*fiOkavango. Jewel of the Kalahari,fl a series of three one-hour films by Partridge Films and the BBC, shows the great beauty and wealth of wildlife in this wetland. (See Video, Regional, Africa; see also the Book Section for several books about this swamp.)

Wetland Drainage: Page 4

Until the 20th century, wetlands covered large areas in Asia, from the swampy grasslands at the base of the Himalayas to the marshes and deltas of Thailand, Cambodia and Vietnam. With the growth in human populations and pressure to raise more crops, millions of acres were filled or converted to rice paddies. Thailand has lost virtually all of its freshwater wetlands, and China, Laos and Vietnam have also incurred great losses. The majestic Sarus crane (*Grus antigone*) no longer nests in Thailand, and throughout Asia, cranes are threatened by loss of wetland habitat. Eight of the world's 15 crane species are found in Asia, and nearly all are considered endangered. They breed from high Tibetan reed lakes to coastal marshes, and all these habitats are being lost. The endangered black-necked crane (*Grus nigricollis*) breeds in high altitude sedge marshes and grasslands of the Tibetan plateau. Several of its important breeding marshes in western China have dried up as a result of intensive grazing and plowing of the steppe grasslands, and portions of its wintering wetlands in Bhutan are being drained (BI 2000). A dam planned on the Lhasa river also threatens wintering cranes. These beautiful cranes now number only 5,000 to 6,000 birds, and they are in decline (BI 2000).

Colorful Asian storks, once widespread, are now threatened with extinction as their habitat declines yearly. Seven species are now listed by BirdLife International in *Threatened Birds of the World* (BI 2000). They include the vulnerable milky stork (*Mycteria cinerea*), the endangered Storm's stork (Ciconia stormi), the vulnerable lesser adjutant (*Leptoptilos javanicus*), the endangered greater adjutant (Leptoptilos dubius), the endangered Oriental stork (*Ciconia boyciana*), the near-threatened painted stork (*Mycteria leucocephala*) and the near-threatened black-necked stork (*Ephippiorhynchus asiaticus*). Such a diversity of storks is found nowhere else on the planet. North America has only one species, the wood stork, and only the white stork is native to Europe. Some breed in the mangroves of Indonesia, and others, like the Oriental stork, which greatly resembles the white stork, winter in marshes in Japan, North Korea and Taiwan, where they face hunting, draining of wetlands, pesticides and pollution. The total world population of this bird is estimated at only 2,500 and declining (BI 2000).

Wetland Drainage: Page 5

In the United States, early American colonists began draining wetlands in the 17th century, and various laws encouraging this activity were enacted through the years. Over half of wetlands of all types, and some 70 percent of riparian, or riverside, wetlands in this country, have been destroyed (Rezendes 1996). Losses continue under the Clean Water Act's weak regulations that place the US Army Corps of Engineers in charge of issuing permits to developers who apply for permission to fill in wetlands. The Corps' major role has been the construction of dams and levees, dredging of ports, and other water projects responsible for causing numerous extinctions among the nation's wildlife. These regulations exempt small and temporary wetlands, such as vernal pools and prairie potholes, and the

Corps has been less than vigilant in enforcing wetland protection (Williams 1996). Federal legislation should change the authority designated to oversee wetlands conservation from the US Army Corps of Engineers to the Department of the Interior. The United States may be the only country in the world to allow its dike and canal makers to oversee conservation of these ecosystems. Wetlands protection should be far stricter in both federal and state legislation to prevent further losses.

Unfortunately, these important wetlands are often not protected by law in the United States, or, in the case of states such as Massachusetts, are protected only by some towns and only if officially registered as vernal pools (Appel 1999). These pools are being destroyed, often intentionally, by developers and homeowners who fear that building on or near the pool would be restricted (Appel 1999). Even when the pool itself is not destroyed, its water supply can be cut off by building nearby. A prime area for wood frogs in Framingham, Mass., disappeared, even though registered as a vernal pool, because the surrounding 25 acres of woodland were cut to construct a cinema complex (Ridout 2000). The required 125-foot buffer area of woods that was left surrounding the pool did not supply enough runoff water; the vernal pool dried out and the frogs disappeared (Ridout 2000). The disappearance of turtles from many areas in the East has been blamed on the filling of these important habitats where they migrate to lay their eggs.

Many swamp forests in the East and in the Midwest, as well as potholes essential as breeding habitat for waterfowl and stopovers for the continent's shore birds, were drained with government subsidies. Iowa lost 98 percent of its potholes; Minnesota, 75 percent; South Dakota, 35 percent; Montana, 27 percent and North Dakota, which had one-third of all these ecosystems, 49 percent (Williams 1996). The latter state's legislature discourages protection of the remaining potholes by requiring approval of conservation easements or purchase for conservation by an agricultural council (Williams 1996). This reflects the failure of federal and state governments to value wetlands for their ecological importance rather than for commercial purposes such as agriculture, construction or mining. In other parts of the world, similar attitudes prevail. The black-faced spoonbill (*Platalea minor*), a large white wading bird of Asia has been reduced to only about 700 birds (BI 2000). More than 200 of these birds winter in Taiwan's Chiku marsh, near the capital city, Tainan, now under great threat from development (WESPA 1994). A Taiwanese government official, when questioned about proposed drainage of the marsh, stated to CNN on January 6, 1994, "We can't stop our industrial progress for a few birds." Throughout the range of these endangered birds in east Asia's coastal wetlands, development has drained their habitats or converted them into aquaculture ponds (BI 2000).

Coral Reefs

The beautiful and diverse coral reefs of the world are today more threatened than they have been for many millions of years. A survey in the 1980s found that damage had occurred in coral reefs in 93 of the 109 countries where these rich ecosystems are found (Wells and Hanna 1992). At least 10 percent of coral reefs around the world had been damaged beyond repair, while 30 percent were in critical condition and expected to disappear within 10 to 20 years; another 30 percent were expected to die by 2050 (Carter 1997). Research in 1999 found further damage: one-third of all coral reefs were dead and 90 percent degraded to some extent.

In the Maldive Islands in the Indian Ocean, all the coral around inhabited islands has been excavated. This limestone material has been fashioned into houses. An estimated 95 percent of these reefs are dead or dying (Zuckoff 2000b). The result has been lowland flooding by the sea because these protective barriers were destroyed. Because of the growing numbers of tourists, tour boats, scuba divers and spear fishers, many ancient reefs are declining in species diversity or dying out altogether. In some areas, hotels are often built with inadequate pollution and erosion controls near coral reefs. Even touching a coral can harm the delicate outer layer, which can take 100 years to recover.

Dynamiting and poisoning reefs to obtain fish are methods banned throughout Asia, yet they regularly occur. David Doubilet (1999) has spent much of his life photographing coral reefs and has witnessed such activities. On one

occasion while diving in the Philippines, he saw large areas of coral reefs reduced to white rubble. The cause was nearby boatmen who lobbed bottles of homemade explosives into the sea (Doubilet 1999). They were chased off by a marine official who fired a pistol round over the poachers' heads, but on inspecting the results in the coral reef, Doubilet saw fish spinning aimlessly in convulsions or belly-up amidst the craters of blast sites (Doubilet 1999). Beginning in the 1960s, Philippine fishermen pumped cyanide poison into 33 million coral heads at a rate of 330,000 pounds yearly (Chadwick 1999). Approximately 95 percent of the reefs of the Philippines have been destroyed from the combined effects of sewage pollution, dynamiting and the use of cyanide to obtain tropical fish for the pet trade (Chadwick 1999). These fish usually die within weeks from the cyanide (Wells and Hanna 1992). In the rich reefs surrounding Indonesia, a recent trade has begun for live fish which are kept in aquariums to be consumed in restaurants in Hong Kong and other major cities; the fish are stunned by small amounts of poison and the coral often dies after being sprayed (see Trade, Fisheries).

Seashell and pearl harvests have depleted many reefs of species important in controlling reef predators. The Crown-of-Thorns starfish of the western Pacific was once preyed on and kept in check by 12-inch giant triton mollusks, a species collected heavily for the shell trade. The fish that controlled populations of Crown-of-Thorns starfish have been killed off by fishing, further causing imbalance to reefs. Sewage or agricultural runoff promotes the growth of plankton that also encourages these starfish to multiply to pestilential levels, killing off large portions of coral (Chadwick 1999).

Siltation runoff from clear-cutting forests near shore and agricultural plowing has become major factors in the death of 95 percent of Philippine reefs and the dying of reefs in the Florida Keys and elsewhere. When silt comes to rest on live coral, the coral is smothered. Fertilizers and sewage encourage the growth of bacteria, viruses and diseases, such as aspergillosis, that have devastated hundreds of coral reefs in the Caribbean (Chadwick 1999).

Coral bleaching, in which colorful corals turn white and die, is affecting a growing number of reefs. Even a slight rise in ocean temperature can kill off the symbiotic algae living in the coral. The algae gives coral color and without it, the coral animals die. Global warming has been mainly responsible for gradually raising ocean temperatures, and should it continue, the majority of the world's reefs will die out. Household bleach, used by fishermen to stun fish, can also cause bleaching. UV radiation from ozone depletion may play a major role, as well by killing off the symbiotic algae (Chadwick 1999). In some cases, coral bleaching can be temporary, and corals can recover if water temperatures cool before too much time has passed or if the corals are not also being attacked by pollutants, pesticides or a different type of algae produced from fertilizer nutrients in the water.

The Great Barrier Reef has incurred die-offs of coral in many areas. This massive reef is considered one of the great natural wonders of the world, with a great diversity of fish and corals. Coral bleaching has killed various parts of the reef in recent years, and in 1998, the warmest year ever recorded, large sections of the reef died, leaving white skeletons in place of dazzling fish and colorful corals (Zuckoff 2000b). Some reefs recovered when temperatures cooled, but most did not. Scientists meeting at the fourth meeting of the International Coral Reef Symposium in 2000 warned that global warming and other threats must be stopped if the world's coral reefs are to be saved (Zuckoff 2000b). At the present rate of destruction, one scientist estimated that coral reefs will be gone in 30 to 50 years (Zuckoff 2000b). Global warming is not being arrested, however, as countries, led by the United States, the largest producer of greenhouse gases, continue to pollute the atmosphere.

Mangrove Destruction

In the Americas, mangroves grow as far north as southern Florida and the Florida Keys, throughout the Caribbean region; and in South America, they occur in a narrow band lining the Amazon River and on the coasts of French Guiana and northern Brazil. Mangroves are also abundant in river deltas of West Africa, portions of the Middle East,

east to Malaysia, Papua New Guinea, northern Australia and on many western Pacific islands.

The Sundarban mangroves surround the Ganges Delta, extending along the coasts of eastern India and Bangladesh. They cover 2,300 square miles and penetrate far inland along the Ganges River, forming an intricate maze of rivers, creeks and canals that are flooded daily by ocean tides (Dugan 1993). Wildlife is abundant in these mangroves. At least 35 species of reptiles, 270 bird species and 42 mammal species are native (Dugan 1993). The most famous of these is the magnificent Bengal tiger (*Panthera tigris bengalus*), whose largest population may be found here. India has set aside a large reserve for tigers and other wildlife in its portion of the Sundarbans; as many as 350 to 400 tigers are present in Bangladesh's portion, with 250 to 300 in India's (Dugan 1993). Even in this maze of mangroves, however, tigers are under siege from poachers, and since the early 1990s, their numbers have declined even here from habitat loss, poaching and loss of prey animals to hunters.

The Sundarban mangroves are heavily exploited by the over 300,000 people who live here. Each year 9 million cubic metres of timber and pulpwood and 106,400 tons of fuel wood are cut by Bangladeshi and Indian natives (Dugan 1993). Overcutting has affected the fisheries habitat that provides about 150,000 tons of fish per year for the 10,000 fishermen in these mangroves (Dugan 1993). So many of the outer island mangroves have been destroyed that storm surges caused by cyclones now move much further inland, leaving destruction and loss of life in their wake (Hauser 1992). Fragile mangroves have been destroyed for a fishing jetty and prawn culture area inside the Indian Bhitarkanika Sanctuary for endangered Olive Ridley Sea Turtles (*Lepidochelys olivacea*). These projects were funded by the World Bank. This prime wildlife area is vital to white-bellied sea eagles and threatened Indian smooth-coated otters of the same species as Maxwell's otter (see above). The Olive Ridley sea turtles experienced a major die-off in February 2000.

The cutting of mangroves in southeast Asia has destroyed thousands of acres to supply paper mills in Japan (Collins 1990). Prior to the Vietnam War, scientists estimate that at least 1,000 square miles of the Mekong Delta were mangrove and paperbark forest. Eleven million gallons of herbicide defoliants (known as Agent Orange) were sprayed during the war, destroying half the delta wetlands, or 480 square miles of mangrove and 100 square miles of paperbark (Dugan 1993). To compound the damage, the forests beyond the mangroves were burned and sprayed with herbicides, and canals were dug by the U.S. armed forces to drain the flooded areas (Dugan 1993). Much of this land remains poisoned and infertile 35 years after the end of the war; replanting is taking place on non-poisoned acreage. The human toll has been significant: thousands of Vietnamese died from the effects, and many children born since the war have had a high incidence of birth defects, serious skin disease and tumors; American soldiers exposed to these chemicals suffered a wide range of cancers and other major health problems. Only recently has the US government acknowledged the full range of the effects of these herbicides and paid compensation to ailing servicemen.

The Mekong River delta is native to 260 species of fish, 35 reptile species, 6 amphibian species, 386 bird species and 23 mammal species (Simon 1995). Among these are the endangered Estuarine crocodile (*Crocodylus porosus*), a species in decline throughout its southeast Asian range, and the threatened eastern Sarus crane (*Grus antigone*), which disappeared from Vietnam during the war but later returned (Simon 1995). One of the rarest birds in the world, the giant ibis (*Pseudibis gigantea*), is the largest of all ibises, a silvery-gray bird with pink legs. The Mekong Delta system in Cambodia was its stronghold in the 1920s, where it was commonly seen, but a 1994 survey found no giant ibis. Wetland drainage for agriculture, hunting and deforestation have pushed it to the edge of extinction. Extinct in Thailand, only two birds have been seen in southern Laos in recent years Œ in 1993 near a proposed protected area (Collar *et al*. 1994). Once native to the Mekong Delta in Vietnam, it was probably extinguished during the war. Cambodia has some lowland wetlands and may have undiscovered populations of giant ibis, but at present the estimated total world population is 50 birds and declining (BI 2000).

At present, the greatest threat to mangroves worldwide is the farmed shrimp industry. Mangroves are natural nurseries for shrimp, and this industry destroys the mangroves by cutting them in wide swaths to make room for artificial ponds. These ponds are closed off to prevent the shrimp from swimming back to the sea. Without the natural cleansing of the tides, the ponds soon become polluted and laden with chemicals added by the farmers.

Although not all farmed shrimp are raised in this environmentally destructive manner, in some countries this type of farming predominates. The worldwide shrimp farm industry is worth at least $8 billion (Mydans 1996) and produces 783,200 tons of shrimp per year, about 30 percent of the world's shrimp production (Nixon 1996). Fifty countries now farm shrimp, many with aid from the World Bank. The governments of India and Ecuador have banned the further cutting of mangroves for shrimp farms, but in Ecuador, 85 square miles of mangroves were illegally cut after the ban. In the Philippines, 1,000 square miles of mangroves, 67 percent of the country's total, were destroyed between 1920 and 1980, most being converted to ponds for farming shrimp and milkfish (Dugan 1993).

Grassroots environmental organizations have recently appealed to international conservation groups and lending banks to stop funding the farmed shrimp industry and to the public to boycott all farmed shrimp. One such group, the Seattle-based Mangrove Action Project, has united with The Sierra Club of Canada and other organizations to lobby against tropical shrimp farms. The shrimp pond industry may die out on its own, however, because of disease outbreaks in the ponds. Various types of virus and bacterial infections have spread through shrimp ponds because of their stagnancy and the crowding of shrimp. More than 42,000 acres of ponds in Ecuador now lie fallow, having been swept by disease, and many fishermen and shrimp farmers now see the wisdom in protecting the mangroves because these trees are able to filter water and maintain a clean environment for shrimp far more efficiently than human-made holding ponds along the coasts (Nixon 1996). High-technology aquaculture buildings have been constructed that use aerated and filtered water and operate independently of natural ecosystems. Some of these facilities have been constructed in Thailand and elsewhere. They are a far more environmentally friendly method of producing shrimp. A key element is the captive-breeding of shrimp in such a facility, rather than removal of wild larvae from the ocean.

Noise, Boat Collisions and Debris

The once quiet oceans now rumble with huge cargo, cruise and naval ships whose noisy engines drown out the delicate rumblings, and songs whales make to establish territory and communicate, as well as the myriad sounds other creatures emit in the ocean depths vital to their survival. The North Atlantic, Mediterranean and Baltic are especially busy shipping lanes. Wildlife now has new and lethal noises to cope with. The Navy has been testing anti-submarine sonar called Low Frequency Active. Powerful sonar waves are broadcast underwater to test a means of detecting quiet enemy submarines (White 2000a). These sonar waves can travel hundreds of miles and be extremely loud. Humpback whale (*Megaptera novaeangliae*) males emitting their complex, haunting songs to establish territory have become silent or moved away when these waves were broadcast. More ominously, testing in 1995 off the coast of Greece coincided with an unusual stranding of Cuvier's beaked whales (*Ziphius cavirostris*) resulting in the deaths of these seldom-seen whales. In March 2000, Ken Balcomb, a biologist from the Center for Whale Research who is familiar with sonar, was present when a stranding occurred while Navy tests were taking place nearby. Fifteen animals stranded, including dense beaked whales (*Mesoplodon densirostris*) and other species of beaked whales, a Minke whale (*Balaenoptera acutorostrata*) and a spotted dolphin (*Stenella frontalis*). All washed up on the shores of a Bahamian island; when pushed back into deep water, they were unable to remain upright, clearly unbalanced and disoriented, and nine died (White 2000a). Along with Harvard biologist Darlene Ketton, Ken Balcomb performed necropsies on several whales, finding their ears full of blood and, in one case, hemorrhages striped the lungs; further testing discovered that a whale had suffered a concussion, apparently the result of acute trauma from pressure (White 2000a). A press conference organized by the Animal Welfare Institute following these findings featured Ken Balcomb and other whale experts, who attested to the fact that the sonar is reckless, unnecessary and lethal to whales. Soon after, the Navy canceled testing of active sonar off New Jersey, as well as its scheduled tests on sperm whales in the Azores (White 2000). This technology fills the ocean with penetrating sound waves that greatly disturb or kill marine mammals, interfering with their own sonar and natural behavior.

A major cause of mortality for Florida manatees is collisions with boats. Manatees struck by motorboats or their

propellers can be killed instantly, or may suffer slow, painful deaths from deep slashes and internal injuries. In some cases, these strikes have been intentional. CNN recently reported a case of a woman who witnessed a young man in a motorboat repeatedly driving over a mother manatee and her calf until both were dead. She called the state law enforcement division, but by the time officers arrived, the perpetrator was gone. Many calves are orphaned when their mothers are killed, and only if they are found within hours can they be rescued and cared for by Sea World or other aquariums in Florida. In the first half of 2000, the state determined that 61 deaths were caused by watercraft, just short of the all-time high of 67 for the entire year of 1999. These figures may be lower than the actual mortality, since some manatees may be struck and sink, while others, whose bodies are found, may show no outward sign of injury, having been struck by the bow or side of a boat. These collisions occur with such frequency that virtually all adult Florida manatees have propeller scars on their backs.

The present system of posting speed limits has not been effective in reducing collisions, since so many boaters refuse to obey them and enforcement is inadequate. Manatees swim long distances to find warm water during the winter, passing through shipping lanes and most of southern Florida's navigable waters. This creates a problem that the State of Florida and the Fish and Wildlife Service have not properly addressed, yet one that must be solved to preserve this species. Apparently, manatees do not hear motorboats coming. Research is taking place on the placement of some type of noisemaker attached to the underside of boats to warn them. Even this would not result in a halt to all manatee-boat collisions, however, because these animals are too slow-moving to avoid high-speed boats. Boat propeller guards would also reduce manatee deaths and injuries, as well as human injuries caused by accidents with these sharp blades, but they have not been required by law. The number of pleasure craft in Florida has risen exponentially in recent years, with few laws and regulations governing those who propel them, such as strict regulations on sobriety and competence to handle the boats. Heavy boat traffic has also resulted in human fatalities and injuries from collisions.

Two lawsuits were filed in January 2000 on behalf of the Florida manatee. A coalition of 18 environmental and animal welfare groups, led by the Save the Manatee Club, sued the State of Florida, the US Army Corps of Engineers and the US Fish and Wildlife Service. The Animal Welfare Institute's companion organization, the Society for Animal Protective Legislation, has worked with the coalition's legislative team to obtain $500,000 from the Congress for manatee protection. The corps was sued for its repeated issuance of permits for development in manatee habitat without analyzing the cumulative effects of the permits on the species or its habitat. The suit charges the Fish and Wildlife Service with failure to properly enforce the Marine Mammal Protection Act of 1972 and the Endangered Species Act to prevent mortality and to conserve the species. The US Fish and Wildlife Service failed to designate adequate sanctuaries for manatees where boat traffic would be restricted, reducing its proposed list of sites from 150 in Florida to 10 to 15 (Daley 2001).

The second suit was filed against the Florida Fish and Wildlife Conservation Commission, which has not complied with the Florida Manatee Sanctuary Act of 1978, enforced speed limits, or taken other measures designed to protect these vulnerable animals. The mortality rate from all causes is far greater than the number born, pushing manatees toward extinction. Florida Governor Jeb Bush angered conservationists in late 2000 by allowing the licensing of more boat slips in Sarasota, although the county had not completed a required plan to protect manatees (Daley 2001).

The future is bleak for the approximately 3,000 surviving Florida manatees unless dramatic action is taken (Daley 2001). Their survival has become critical. Other causes of mortality, such as death from red tide, pollution or cold weather, add to the toll. In 2000, for example, 273 manatees died from all causes, close to 10 percent of the entire population (Daley 2001). Since manatees have a single young only every 5 to 7 years, they cannot sustain such losses. These gentle and affectionate animals have been on Earth for 45 million years, yet a lack of concern and willingness to alter our recreational boating habits may eliminate them in Florida. Elsewhere in the range of these manatees, far stricter regulations have been imposed on boat traffic. In Belize, for example, very few manatees have boat propeller scars because many areas are off-limits to all motorized boats, and tours are conducted in boats propelled by poles.

There are two major threats to whales and marine mammals causing their elimination in many areas. Fishing

vessels throw out ropes, nets and other debris that entangle marine mammals, often lethally, and vessels of all types present the danger of mortality through collisions. One or more highly endangered North Atlantic right whales (*Eubalaena glacialis* die each year from rope and net entanglements or collisions with ships; their population is only at about 300. In 1995, a whale of this endangered species became wrapped in lobster line and died off the Rhode Island coast. In September 1997, another whale became hamstrung with nylon netting around his head, towing a 9-foot sea anchor near Nova Scotia; it took 8 1/2 hours to free him, after a 25-kilometer chase by a rescue team. A young blue whale (*Balaenoptera musculus*) was killed when a ship collided with it; the ship entered a Massachusetts port with the whale impaled on its bow. In early 2001, three dead fin whales (*Balaenoptera physalus*) washed ashore along the Atlantic coasts of the United States, killed by ship collisions. For North Atlantic right whales, such collisions may end in their extinction, unless means are found to prevent them. These whales have a single calf only once every five years and are dying at such a rate that scientists expect their extinction within less than a century.

Plastic bags and fishing gear have been found to strangle and suffocate endangered sea turtles, marine mammals and sea birds. Endangered albatross on Laysan Island are among the many species to have died after ingesting plastic materials. They also feed their chicks plastic items they mistake for food, unintentionally killing them. Sea turtles, dolphins, whales and sea lions around the world are drowning and strangling in fishing lines and nets. One endangered fin whale that washed ashore dead in Biscayne Bay, northern Spain, in 1997 was found to have ingested huge amounts of plastic sheeting and bags that clogged its digestive system. Each year millions of balloons are released to the winds, and untold numbers end up floating in the oceans, a peril to wildlife. One young sperm whale (*Physeter catodon*) starved to death after swallowing a single balloon that blocked its intestine. Endangered sea turtles die after consuming plastic bags and balloons, mistaking them for jellyfish. Non-biodegradable plastics and nylon nets and ropes in the ocean will present lethal threats to wildlife for the indefinite future. Although international treaties have been signed that regulate such dumping, to date no national or international program has attempted to remove debris, such as plastic items, nets and fishing lines, from the oceans.

Toxic Chemicals

Some chemicals, such as Polychlorinated Biphenyls (PCBs) and pesticides, have entered aquatic systems, causing birth defects in water birds and other wildlife. PCBs, manufactured by General Electric, were used for decades in refrigerators and other industrial uses until it was discovered that when released to the environment, they had serious effects on wildlife. American bald eagles have been among the species affected by PCBs, producing chicks with crossed bills and other defects.

Beluga whales (*Delphinapterus leucas*) in the St. Lawrence River have also been affected. Isolated from members of their species living further north for thousands of years, they have declined dramatically in recent years. Many of these beautiful whales, known for the lyrical songs they sing to one another, have been found dead with tumors, malformations and impairment of female reproductive organs. This river, which links Lake Erie to the Atlantic Ocean, has become severely polluted with chemical contaminants, resulting in declines in wildlife. American eels (*Anguilla rostrata*) accumulate high levels of toxins on their spring migration from the Great Lakes down the St. Lawrence River to the sea and contaminate the Belugas when they feed on them. A major source of PCBs in the river is a sunken barge in the Gulf of St. Lawrence, which has been oozing these toxins for more than 25 years; its cleanup is difficult because there is fear it will break apart either on its own or if moved (Nickerson 1996).

The St. Lawrence belugas numbered about 5,000 in the 1600s, but whaling, which went on until the 1940s, reduced their population to about 2,500 (Katona *et al*. 1993). Before they could fully recover, contaminants from industries surrounding the Great Lakes and St. Lawrence seaway took a tragic toll on them. Today, only 400 to 500 belugas remain in this river. A study by Dr. Pierre Beland of the St. Lawrence National Institute of Toxicology in Quebec found that 40 percent of all belugas necropsied had malignant tumors in their digestive systems, mouths, esophagi, intestines and respiratory systems. Two percent of the belugas found at the mouth of the Saguanay River were visibly deformed. PCBs, which cause malformations in mammals and birds, were found at levels up to 3,400 parts per million (ppm) in the milk of a lactating female beluga and up to 576 ppm in blubber (Katona *et al*. 1993). Fish is unfit for human consumption if it contains 2 ppm of PCBs.

In 1976, the United States banned the manufacture of PCBs, and other industrialized countries followed. But in the nearly 50 years that they were manufactured, an estimated 3.4 billion pounds had been produced, and they have become pervasive in the environment, spreading on air currents and through aquatic food chains. PCBs are now found in animals thousands of miles away from locations where these chemicals were used, in the blubber of whales and the milk of nursing polar bears (Colborn *et al*. 1996). Once PCBs are deposited in the fat of animals and humans, they remain indefinitely and do not biodegrade. These and related chemicals continue to cause birth defects and reproductive failure in wildlife (Colborn *et al*. 1996). Virtually all humans carry PCBs and other persistent chemicals in their body fat, and a nursing mother passes these chemicals on to her baby (Colborn *et al*. 1996). The higher the animal on the food chain, such as birds of prey, whales, seals and land predators, the higher the concentrations of PCBs and chlorinated hydrocarbons like DDT, multiplying up to 3 billion times as they move up the food chain from microorganisms to polar bears (Colborn *et al*. 1996).

PCBs have also contaminated killer whales (*Orcinus orca*) in the Pacific Northwest. The Institute of Ocean Sciences tested 47 of these giant dolphins living off the British Columbia coast, finding levels two to five times as high as belugas in the St. Lawrence River (NG 2000). Just to the south, the killer whales off the San Juan Islands of Washington State are in decline, with the highest PCB levels ever found in wildlife (White 2000b). Deformed polar bear cubs have been found in Norway's Svalbard Islands. Researchers in 1996 found seven cubs with both male and female sex organs (NG 1999). These islands receive three times the PCB exposure of northern Canada, where only one such case has been seen (NG 1999). Pesticides and PCBs are carried here by air and water from Europe, North America and Asia.

During the 1990s, bald eagles (*Haliaeetus leucocephalus*) feeding on seagulls near Lake Superior accumulated contaminants 20 times higher than fish-eating birds of the same area (Colborn *et al*. 1996). Bald eagle chicks hatched in the Great Lakes were found with severe birth defects, from crossed bills to missing eyes, clubbed feet and a wasting disease that causes chicks to weaken and die (Colborn *et al*. 1996). Scientists have detected high residues of contaminants such as dioxin, PCBs and furans in the eagles. PCBs are the most likely cause of these abnormalities, but several chemicals might interact with toxic effects (Colborn *et al*. 1996).

Almost the entire length of the Hudson River has been contaminated by PCB dumping and outflow from a General Electric plant. Seepage of PCBs continues from the plant foundations, even though the chemical is no longer

produced here, rendering fish from the river commercially unmarketable. After decades of conservation, striped bass recovered from heavy fishing in the Hudson River, but they contain such high amounts of PCBs that if caught by sport fishermen, they cannot be sold, and pregnant women are warned not to eat them. The removal of these residues from the Hudson and other river bottoms has not been carried out because of the difficulty of containing them in such a way as to prevent their dispersal into the atmosphere. General Electric was ordered to dredge the PCB residues in 2000, but local communities along the Hudson River have expressed opposition, fearing that they would disperse throughout the river. These chemicals may be impossible to eliminate from the Earth.

Like PCBs, persistent types of pesticides and herbicides, even in minute quantities, can be stored in the tissues of aquatic organisms and accumulate in greater and greater amounts in the ascending food chain. These chemicals can accumulate to toxic levels, killing the animals or interfering with their production of eggs, a known effect of chlorinated hydrocarbon pesticides, primarily DDT, that nearly caused the extinction of the Peregrine falcon (*Falco peregrinus*) in North America and great declines in bald eagles and other birds. The most injurious of these, DDT, dieldrin and chlordane, have been banned in the United States for most uses, but are used in foreign countries and remain in many areas where they were manufactured.

Toxic Chemicals: Page 2

Although persistent pesticides of the DDT family have been banned in the United States, they are still manufactured here and exported for control of malaria to many tropical countries. DDT is still present in a 17 square mile dumping area in the coastal waters off California. Montrose Chemical Corporation and two other companies dumped some 100 tons of DDT between 1947 and 1971, when it was banned. These ocean residues continue to enter the food chain through fish and other organisms. This has affected birds who feed on these fish, including brown pelicans and bald eagles on the California coast, who still laid thin-shelled eggs as a result of DDT contamination of their food supply 30 years after the ban. Highly toxic pesticides banned in the United States are still being used around the world, killing large numbers of birds and other wildlife. Diazinon, a pesticide commonly used on golf courses in the United States, and highly toxic to geese and other birds, was recently banned in the United States, along with Dursban, a commonly used lawn chemical. Pesticides and related chemicals that kill and cause mutations in wildlife are indeed still being broadcast in the United States as well as in other parts of the world. Only with more oversight and strong legislation to limit use and export of these chemicals can wildlife and aquatic ecosystems be protected.

DDT and other pesticides contaminate entire ecosystems in tropical countries, and some North American birds winter in areas where these chemicals are still used. Between 1992 and 1994 alone, the United States exported at least 247 million pounds of banned or restricted pesticides to the rest of the world. DDT, for example, is widely used for malaria control in Africa and Asia. Virtually no laws restrict this trade, which has the potential of causing major wildlife declines and extinctions.

In agricultural areas in northern Florida, American alligators (*Alligator mississipiensis*) have been found with abnormalities and poor reproductive success thought to have been caused by pesticides in their food supply (Colborn *et al*. 1996). Many synthetic chemicals react on animals in a manner similar to hormones. Dicofol, a pesticide related to DDT, was widely used in the vicinity of Lake Apopka, finding its way into the waters and causing abnormalities in alligators. Males developed unusually small penises and defective testicles, and females had abnormal eggs and sex organs (Colborn *et al*. 1996). The male alligators in this lake had elevated levels of female hormones, equal to those in normal female alligators, and one-fourth the normal level of testosterone; females had estrogen levels double the norm (Colburn *et al*. 1996). The reproduction of alligators in the area has nearly ceased altogether, with almost no eggs hatching (Colburn *et al*. 1996). Red-eared turtles of Lake Apopka, considered unlikely to be affected by this pesticide since they are plant-eaters, surprised researchers by exhibiting reproductive difficulties as well. Many turtles

discovered had not developed normally as either male or female (Colborn *et al*. 1996).

Toxic Chemicals: Page 3

Within the past few decades, an increasing toll of wildlife has been taken by toxic chemicals in aquatic environments. Massive seal kills have occurred in the North Sea, and in January 1996, the body of an endangered sperm whale (*Physeter catodon*) washed up on a Danish beach. Analyses of its tissues revealed dangerous levels of heavy metals Œ so much mercury and cadmium that the intestine had to be buried at a special dangerous waste site. The amount of toxic cadmium was 20 times higher and the quantity of mercury double that normally found in fish. The North Sea has become extremely polluted, laden with toxic chemicals from industry and untreated sewage.

Off the west coast of Mexico, a large number of dead dolphins and Gray Whales have washed ashore since 1997. Some were the apparent victims of cyanide poisoning. Drug traffickers use a cyanide-based chemical to mark ocean drop-off sites, and this chemical is thought to be responsible for poisoning these and hundreds of other marine mammals and fish. Some Gray Whales that wash ashore may be suffering other maladies related to toxic chemicals or contamination, combined with a lack of food. Numbers have risen off U.S. coasts: 278 in 1999, more than 300 in the first half of 2000 (White 2000b). The number of Gray Whale calves also declined from 1,520 in 1997 to 282 in 1999 (White 2000b). Many of the dead whales were emaciated.

Very high levels of methyl mercury have been detected in the Everglades. A study by Greenpeace found that this highly toxic metal was emanating from trash incinerators operating on the East Coast. Endangered Florida Panthers (*Felis concolor coryi*) have been found dead with toxic levels of mercury in their bodies. These endangered cats, an unusual subspecies of the Cougar, are close to extinction, with a population of fewer than 30 animals. Mercury is also present in sewage sludge, much of which is spread on land as fertilizer. In one year alone, 1996, the state of New Hampshire spread 1.6 tons of mercury on land (Giordano 1998). Their dairy farms are among the users of sludge obtained from chemical treatment plants in Massachusetts and other states (Giordano 1998). Common Loons, known for their haunting cries once heard in virtually every one of New Hampshire's thousands of lakes, have declined precipitously in recent years, their bodies laden with very high levels of methyl mercury (Giordano 1998).

In spite of the clear danger presented by mercury, little has been done to limit its use and disposal. Only Vermont has passed legislation that bans disposal in landfills and requires labeling of products such as fluorescent light bulbs, light switches, batteries for hearing aids and watches and thermometers. Mercury is also used in dental fillings. Boston banned the sale of household mercury thermometers in 2000, and the ban is expected to be extended statewide in 2001 (Daley and Kremmer 2001). Several other states are considering legislation to require labeling of mercury-containing products and banning their disposal by flushing or placing in the trash. New York State proposed legislation in 2001 that would eliminate the use of mercury in such products beginning in 2004 (McKinley 2001). The Environmental Protection Agency and the New York Department of Environmental Conservation began to cooperate in regulating mercury sent into the air by incinerators five years ago, but coal-burning power plants, which emit about 30 percent of all mercury emissions, are not subject to any federal or state restrictions (McKinley 2001).

Toxic mercury residues from metals companies is often shipped out of the country to nations that accept them. Now, however, some countries are unwilling to allow such shipments. One cargo ship headed for Bombay, India, in January 2001, carrying 20 tons of mercury reclaimed from a Maine factory, set off a tempest of protests by environmentalists in that country who denounced the "toxic trade" (Daley and Kremmer 2001). At least 12 factories in the United States have stocks of tons of mercury, some of which is used in a chemical process to produce chlorine (Daley and Kremmer 2001). India is a major user of industrial mercury as well, but resents becoming a dumping ground for other countries (Daley and Kremmer 2001).

Toxic Chemicals: Page 4

Within the past decade, sea turtles in Florida Bay and the surrounding waters have shown signs of disease caused by toxic chemicals. Hundreds of turtles have been found dead or dying, some with massive tumor growths on their skin, covering their heads, necks and legs. It is thought that these growths are caused by a virus that attacked the turtles because of their lowered immunity system, which was in turn caused by pollution such as runoff from farmland or inadequate food when sea grasses died off. Some of these turtles have been saved by placing them in aquariums for months to build up their immune systems. Because of the increasing number of sick turtles seen, however, and the other problems that these sea turtles face, many scientists now believe that within 50 years, sea turtles will have disappeared from Southeastern waters.

Chemical runoff from agriculture in the reclaimed marshes of central Florida is thought responsible for the outbreaks of red tide organisms that killed hundreds of endangered Florida manatees (*Trichechus manatus latirostris*) in 1996, devastating their populations. A total of 415 manatees died that year, a record number. Of these, a large percentage died from the toxins. The hundreds of dying manatees, who exhibited no symptoms prior to their deaths, caused great concern among scientists and conservationists who cooperated to discover the cause. Analyses of tissues carried out by the Florida Marine Research Institute and federal, state and private agencies finally concluded that red tide toxics produced by dinoflagellates were the cause. Some of the sick Florida manatees exhibited neuromuscular problems consistent with those previously described in manatees exposed to red tides and were taken to a rehabilitation facility at Lowry Park Zoo in Tampa (Turner 1996). Three females recovered over a period of three days, during which time they required assistance to stay afloat for breathing (Turner 1996).

Although red tide is a natural phenomenon, scientists believe that these tides, which have been occurring with greater frequency in recent years, are erupting as a result of effluents, such as sewage and agricultural fertilizers and pesticides (Broad 1996). The average number of Florida manatees that die each year was 100 or fewer prior to 1990, but since then, each year 200 or more die. The effects of pollutants may be a major factor in the doubling of their death rate at a time when toxic chemicals have become pervasive in Florida waters. Since a female manatee has only one young every five to seven years, this death rate is far greater than the recruitment rate.

Toxic Chemicals: Page 5

Pollution-caused mortality of wildlife was, until recently, rare, occurring in isolated areas in the world's oceans. Increasingly, however, these poisons are becoming widespread, and the effects on ecosystems and individual species have been serious. Red tides have affected the Chinese coast in recent years, causing massive fish kills and wiping out fish farms (Chu 2000). They are attributed to sewage dumping. In Hong Kong, where a red tide covered 2,000 square miles, 700,000 tons of sewage is dumped yearly into the nearby Bohai Sea (Chu 2000). Long-term dumping of sewage, toxic chemicals and fertilizer is killing all fish and sea life, creating "dead zones." A dead zone in the Gulf of Mexico off the delta of the Mississippi River covers 7,000 square miles, the size of New Jersey; it spreads west to the Texas coast (Yoon 1998). Caused by a lack of oxygen, 50 dead zones were found in oceans and seas throughout the world by 2000. Cruise ships now number in the thousands, and each one generates a million gallons of waste water, 200,000 gallons of sewage and 25,000 gallons of oil-contaminated water each week, according to the Bluewater Network (Johnston 2000). Even small motor boats are heavy polluters of the air and water, emitting toxic fumes and leaving trails of oil and gasoline in the water.

Toxic Chemicals: Page 6

The spectacled eider (*Somateria fischeri*), a beautiful duck of Alaska and arctic Russia, has incurred great declines that may be related to ingestion of toxic chemicals. The Iowa-sized Yukon-Yuskokwim Delta of western Alaska had 100,000 of these ducks breeding here in the 1970s, but beginning in 1986, they lost 14 percent of their population each year; 95 percent of their original numbers are now gone, leaving only about 5,000 birds (Dunkel 1997). In 1993, the species was listed as threatened on the Endangered Species Act, and a task force set about trying to discover the causes. They found that many of the birds had high levels of lead from Eskimo hunting with bird shot. Although 34 of the 42 Eskimo villages in the delta have passed resolutions in favor of using steel shot over lead shot, most natives apparently believe that the birds are dying out from being studied and handled by biologists (Dunkel 1997). One Fish and Wildlife Service biologist observed a spectacled eider dying of lead poisoning: "She was flopping along [on the ground] and couldn't lift her head . . . She died within an hour" (Dunkel 1997). Lead in sub-lethal concentrations can cause females to abandon nests and males to become infertile.

Lead poisoning has killed other wildlife as well. The magnificent and rare Steller's sea eagles of Russia's Kamchatka Peninsula and northern Japan have been dying of lead poisoning from eating carcasses of deer killed by Japanese hunters (Garcelon 1999). Lead shot cannot be used by United States waterfowl hunters (other than native Americans) because of massive bird-kills in marshes where lead shot accumulated.

Until February 1995, the wintering area of spectacled eiders, where they spend 10 months of the year, was unknown. The Fish and Wildlife Service had attached radio transmitters to several of these ducks, only to find the signals fading during the winter. One radio, however, continued to send out signals which were detected and located by biologists flying over the Bering Sea in a small plane (Dunkel 1997). To their amazement, they saw flotillas of these ducks, gathered in dense flocks south of St. Lawrence Island off western Alaska. Packed close together, their body heat helped keep the ice open. DNA studies determined that these ducks comprised the entire world population of the spectacled eider, converged from Alaska's North Slope, the western Alaskan delta and arctic Russia. Each returns to the location where it hatched, and when one population declines, there is no recruitment from the others (Dunkel 1997). This makes the decline in the Yukon-Kuskokwim Delta population all the more serious. The Bering Sea has been found to contain cadmium, selenium, strontium and other contaminants in high concentrations, which might be another explanation for the decline in these ducks (Dunkel 1997). Their disappearance coincides with the downward population trends of Alaskan mammals that were abundant only a few decades ago. Harbor seals of the Bering Sea have plummeted 60 percent since the 1970s; fur seals, 20 to 40 percent and Steller's sea lions (*Eumetopias jubatus*), a disastrous 80 percent, pushing them to endangered status (Dunkel 1997). Overfishing may play a role in these declines, but since the spectacled eider feeds on mussels and other bivalves, as well as surface invertebrates, and has declined concurrently with the others, contaminants are apparently playing an important role.

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The rivers of Europe may be the most polluted and changed by diversion, dams and channeling in the world. The Rhine, considered the "great open sewer of Western Europe," has lost the majority of its native fish, but pollution control efforts are beginning to show results (Simons 1995). After an absence of 40 years, a single, stranded Atlantic salmon (Salmo salar) appeared after flooding of the Rhine in the Netherlands in the spring of 1995 (Simons 1995). Atlantic salmon are now being reintroduced to rivers of Europe where they have been absent for many decades. A recent report on the Rhine's cleanup status concluded, however, that although much improvement had been made, heavy metals, dioxin, chlorine compounds like PCBs, herbicides and animal manure remain in sediments and are still

released along parts of the river. Common otters (*Lutra lutra*) in Germany have dangerous levels of toxins in their kidneys, livers and fat, and cormorants along the river are laying eggs with thin shells (Simons 1995). Every year in the European Union, 250 million tons of solid industrial waste are produced, most of which is deposited in landfills which can leech into the groundwater (Lanz 1995).

As a result of population and industrial growth, incidents of wildlife killed by pollution in Africa have become more frequent. Formerly pristine lakes in the Great Rift Valley of East Africa are breeding grounds for 80 percent of the world's flamingos. Greater and lesser flamingos by the millions nest and feed in high-altitude, briny lakes. Lakes Nakuru and Bogoria in Kenya have become polluted in recent decades by factories that emit heavy metals and other industrial wastes. People have built towns and cities along the shores that discharge large amounts of untreated sewage into the lakes. Since 1993, several mass die-offs of flamingos have occurred on these lakes. More than 50,000 flamingos died in 1993 and 1995, and two more die-offs in the summer of 1999 and early 2000 killed thousands more. There is a real possibility that the massive flocks of these beautiful pink birds, one of the Earth's great wildlife spectacles, might vanish.

Toxic Chemicals: Page 8

Acid rain is another threat posed to lakes, streams and ponds. Large power plants in Europe and the United States and, most recently, in China, which burn fossil fuels such as coal, have affected forests and aquatic systems hundreds and even thousands of miles away from the source of pollution. In the 1970s, tall stacks were mandated as pollution control to dispel soot particles, sulphur dioxide and nitrogen oxides. Rather than control the problem, they merely spread it by dispersing these pollutants vast distances on the wind. The pollutants combine with atmospheric water and fall to the ground hundreds or thousands of miles away as diluted sulphuric and nitric acids. Coal-fired power plants in England and central Europe have poisoned the lakes and rivers of Scandinavia, while plants in the US Midwest and southern Ontario, Canada, have rendered lakes in New England and Quebec lifeless. In Scandinavia, 20,000 lakes are now lifeless as a result of acid rain (Mason and Macdonald 1986), and in northeastern North America, thousands more have become totally barren (Durrell 1986). Acid rain increases acidity in water to levels toxic to many types of wildlife. In lakes with clear water and few nutrients, acid rain can eliminate all life forms. Acid rain's effects on aquatic species have been catastrophic, eliminating water birds, salamanders, otters, many types of fish, frogs and other temperate wildlife in entire regions.

Coal mines contribute to acidification of aquatic ecosystems as well by exuding acids that poison streams and rivers in their drainage. Thousands of streams in Appalachia in eastern North America have been rendered sterile from coal mines that continue to poison waterways, even when no longer being mined, until they are sealed off. In October 2000, a coal mine sludge retention pond in eastern Kentucky gave way, spilling 200 million gallons of toxic waste into streams feeding the Ohio River (NYT 2000). The state's governor declared a state of emergency in the northeast as water supplies for the entire region were threatened with contamination (NYT 2000).

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Air pollution regulations in the 1980s and 1990s mandated removal of the majority of sulphur dioxides prior to the release of emissions, and this has made a difference in the rate of acidification in North America and Europe. In parts of Europe, lime has been broadcast from small planes on some of these lifeless lakes to lower acidity. Usually, liming has to be frequently repeated and is not always effective. When pollution is decreased, however, life forms return, and air pollution controls have resulted in decreased acidification in some areas.

Dioxin, a chemical emitted by paper and plastic manufacturing plants and incinerators, has been found in aquatic ecosystems. It is toxic to many fish and their eggs, and is considered a cancer risk to humans. Dioxin residues in Lake Ontario, Canada, began killing the eggs of Lake Trout as early as the 1940s, and the species became extinct in the lake by the early 1950s (Colborn *et al*. 1996). Dioxin has been found in high concentrations in Eskimos of the Canadian arctic who eat caribou and seal meat; the latter animals consumed dioxins contained in their food from airborne dioxin generated by incinerators in the United States and Mexico (Hilts 2000).

Toxic Chemicals: Page 10

Chesapeake Bay is the largest expanse of saltwater estuary in the United States. Covering 64,000 square miles, its marshes are watered by its major feeders, the Potomac, Susquehanna, Rappahannock and Patuxent Rivers, along with countless smaller feeder streams from its Maryland and Virginia shores. More than 150 rivers and streams contribute to its 650-mile-wide watershed, which extends over portions of six states (White 1982). The Bay is bordered by 8,100 miles of shoreline, including its tributaries (White 1982). The growth of Washington, D.C. and Baltimore and Annapolis, Maryland, as well as other large cities and suburbs on Chesapeake Bay, and the growth of agriculture that leeches sediments and chemicals, have been responsible for destroying large portions of this great estuary. About 140 square miles of the watershed are built on every year. Urban and suburban growth, agriculture, overfishing and industrialization have all taken a toll on the water quality of Chesapeake Bay. The raising of chickens and hogs in factory farms in the region has increased over the past few decades, producing enormous quantities of fecal material that contaminate rivers and the Bay. During storms, containment ponds have overflowed, pouring pollutants into the waterways which have been implicated in outbreaks of red tide and bacterial disease (Broad 1996). Runoff of pesticides, herbicides, sewage, fertilizer and sedimentation have turned the once clear waters murky in many parts of the Bay. The fragile ecosystem of sea grasses and marshland is damaged.

Fisheries that once produced 28 million pounds of oyster meat and 55 million pounds of blue crab have plummeted. The disappearance of 90 percent of the sea grass from Chesapeake Bay, mainly as a result of chemical pollution and sedimentation, has brought about a crash in blue crab populations, with closures in fishing seasons. Crabs lay eggs and shelter in sea grass. Oyster harvests are now 1 percent of what they were a century ago. Their populations have plummeted, and only with their absence is the role that they play in the health of Chesapeake Bay becoming clear. Originally, the billions of oysters filtered the complete volume of water in the Bay in a three-day period, clarifying the water and removing pollutants (Daily 1997). Their ecological value far outweighed the revenue they produced for fishermen. Overfishing has played a role in the decline of oysters, but the major problem is the disintegration of this once-productive estuary through losses of sea grasses and sedimentation from development and pollution. Another casualty was the Maryland darter (*Etheostoma sellare*), known only from a creek in the northern tributaries of Chesapeake Bay. Not seen for many years, some authorities, including the International Union for the Conservation of Nature (IUCN), consider it extinct (Baillie and Groombridge 1996). The shortnose sturgeon (*Acipenser brevirostrum*) historically ranged throughout the Chesapeake Bay area, where thousands were caught annually. Dams, overfishing and pollution combined to eliminate this sturgeon, and spawning no longer occurs in any of the Chesapeake's feeder rivers. The species is threatened throughout its eastern range and is listed on the Endangered Species Act.

Decades after the Clean Water Act came into effect, the Environmental Protection Agency (EPA) announced in 1996 that only 40 percent of the country's waterways are suitable for swimming or fishing because of pollution from various sources. In 1997, residents of 47 US states were warned by EPA not to eat certain types of freshwater fish after issuance of some 2,200 fish consumption advisories, a new high. These advisories list 45 contaminants in lakes and rivers, including mercury, PCBs, chlordane, dioxin and DDT. In many parts of the United States, well water has been found to be contaminated with pesticides and herbicides. This is especially severe in the farm belt of the Midwest, where the majority of these chemicals are used. According to the EPA, 1.25 billion pounds of weed and

pest killers were used throughout the United States in 1995, an all-time high. Pesticide and herbicide runoff from agricultural fields was found in half of more than 500,000 miles of rivers tested by the EPA in 1995. Homeowners pouring these chemicals on their green lawns are also contributing to the contamination of streams, rivers and water supplies. A new contaminant of groundwater is a gasoline additive, methyl tert-butyl ether (MTBE). This chemical was designed to reduce air pollution to allow gasoline to burn more cleanly, but because of leakage from gasoline tanks around the country, it has entered the groundwater in every state and has been detected in 5.4 percent of wells in a US Geological Survey study. Other solvents added to gasoline were found in 47 percent of urban wells and 14 percent of rural wells (Saar 1999). The drinking-water limits set by EPA were exceeded in many of these wells (Saar 1999). This chemical is suspected to be a carcinogen.

Contamination of aquatic ecosystems has occurred throughout the world. It has played a role in endangering one of the world's rarest birds, the crested ibis (*Nipponia nippon*). Unlike any other ibis in appearance, the bird has white or pearl gray plumage, a shaggy mane of feathers and salmon pink tail feathers, which contrast with bare red facial skin and carmine red legs. Only 66 birds remain, up from 22 birds in the early 1990s, with a captive population in two breeding centers of over 100 birds (BI 2000). These elegant birds once ranged from southeast Siberia, Manchuria and China to as far east as Korea and Japan. For centuries they were hunted for their long nuptial plumes, nearly causing their extinction (Schreiber *et al*. 1989). The Japanese population of the crested ibis declined until only the tiny Sado Island held the last population; the eggs and chicks were killed by crows and jays, and the last birds were taken into captivity (Schreiber *et al*. 1989). Extinct in Siberia in 1917 and thought extinct in China by 1958, a pair was found nesting in Shaanxi Province in central China in 1981. This only remaining breeding population has slowly increased, but with fewer than 100 birds in the wild, it remains endangered (BI 2000).

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Crested ibises require large trees for nesting near marshes, and to protect these birds, China enacted emergency regulations prohibiting logging in the area. Their nest is a flimsy stick platform lined with small twigs, leaves and hay, built in tree branches at heights up to 25 meters (Hoyo *et al*. 1992). Hunting has also been banned, and the Chinese government accorded them official protection, but some wintering birds are still shot (BI 2000). These birds declined in Japan as a result of poisoning by mercury pesticides and other agricultural chemicals applied to rice paddies. Their feeding habits make them very susceptible to poisoning from pesticides because chemicals accumulate in the bodies of their aquatic prey of crabs, frogs, small fish, mollusk and insects. For this reason, pesticides have been banned in nearby rice paddies (BI 2000). The drainage of rice fields in the wintering habitat has reduced food supply, and 80 percent of birds found dead in the wild have starved to death (BI 2000).

Gold mining has become a major peril to rivers and aquatic ecosystems. The ore is treated with cyanide or mercury to remove the gold, and the toxic waste is either flushed into waterways or accumulates in holding ponds. Cyanide is one of the most toxic of all compounds, and it has caused irreparable harm to the pristine rivers of New Guinea, South America and other parts of the world. Cyanide spills have caused massive fish kills and river destruction in Guyana (Associated Press 1995). Brazilian gold miners have illegally polluted rivers in tribal reservations in remote Amazonian forests with cyanide, destroying the entire fish and aquatic fauna upon which tribes had depended for thousands of years.

In Papua (formerly known as Irian Jaya), the western portion of the island of New Guinea governed by Indonesia, the Grasberg Mine contains the world's largest known gold deposit, an estimated 22 million ounces (Bryce 1995). This mine sits atop a peak in the Sudirman Mountains, rising nearly 16,400 feet, and provides habitat for many unique species (Whitten and Whitten 1992). The Grasberg Mine has polluted the Aikwa River, which drains the region and flows to the southeastern coast, killing fish (Bryce 1995). The mine also contains 15 billion pounds of copper and 37 million ounces of silver, for a total value of $50 billion (Bryce 1995). These ores are being mined and transported

through the world's longest slurry pipeline and down the world's longest single-span cable car track to a massive mill (Whitten and Whitten 1992). The entire mountain has already been stripped, reducing it to terraced ridges, and US-owned Freeport-McMoran Copper and Gold Inc., which owns the mine, plans to drill in 75 more sites (O'Neill 1996). The company has been given access to 9 million acres (1.5 times the size of Vermont) by the Indonesian government (O'Neill 1996). French surveyors are seeking uranium in the Vogelkop, or Bird's Head, Peninsula at the far western end of New Guinea, and Australians are searching for gold in the Korowa region in east-central Papua (O'Neill 1996).

New Guinea's great biological diversity is being threatened by this mining. Beautiful birds of paradise, bowerbirds, tree kangaroos and countless other species, ancient forests and wild rivers are gradually being destroyed by mining. At present, forests cover 85 percent of Papua, and clear, free flowing rivers drain the highlands (O'Neill 1996). Much of Papua is without roads, and many areas remain unexplored. New Guinea's extraordinary birdlife is rich in species, totaling 725, more than in all of North America (Beehler *et al*. 1986). Tim Flannery, an Australian mammalogist, is so concerned about the destruction of this island, and the effect on native peoples, that he dedicated his book on New Guinea's wildlife to Chief Executive Officers of mining companies "in the hope that, through reading it, they will understand a little better the people whose lives they so profoundly change" (Flannery 1998). Flannery discovered an extraordinary black and white species of tree kangaroo (*Dendrolagus mbaiso*) in a forest not far from the mine. The mine owners built a large, dam-like structure to contain the enormous amount of mine tailings, all of which are dumped into the headwaters of the Aikwa River. The sediment builds up and smothers the roots of trees, causing vast tracts of forest to die and killing fish and mudcrabs along the coast (Flannery 1998). The tailings area will eventually be so large that it will be visible from space, and the mine has encouraged logging and other intrusions into the wilderness (Flannery 1998).

To the northwest, rivers of southern Borneo have been turned into "polluted deserts" by local people in search of gold. They clear away the rainforest, destroying banks with high-powered hoses (Mydans 1997). Mercury is used to extract the gold dust, contaminating the rivers with 100 times acceptable levels (Mydans 1997). These forests are home to endangered Orangutans and hundreds of animals and plants found nowhere else on Earth.
South America's river banks are also being ravaged by miners who use high- pressure water jets to blast apart the riversides, destroying all vegetation and habitat for endangered giant otters and water birds. Venezuela's largest mine, Minerven, near El Callao, dumps cyanide and metal particles into a man-made pond without liners or barriers to prevent seepage. Trees surrounding the pond have died, and the pond's surface has become so spongy and dense that one can walk on it (Schemo 1996a). Cyanide dumped into the waters is killing fish and poisoning manatees and other aquatic life.

Oil Spills

The interdependence of mangroves, sea grass and coral reefs can result in the decline of all three ecosystems when oil spills occur. After a 1986 oil spill on the Panamanian Caribbean coast, even minute effects could be measured because the mangrove ecology of this particular area had been studied in detail by scientists from the Smithsonian Institution since the 1970s. First the spill killed expanses of sea grasses and their root systems, along with 150 acres of mangrove trees and their roots in a thin strip along the coast (Luoma 1993). Following this, the waves were able to loosen and suspend the bottom sediments, and these mixed with oil particles which sank to the sea floor; each rainy season, the oil was stirred up and re-suspended (Luoma 1993). This annual flushing of the oil contaminated the entire ecosystem and gradually killed the coral reef (Luoma 1993). Up to 96 percent of corals on heavily polluted reefs died, and even at depths of 12 meters, 45 percent of corals perished; many of the surviving corals suffered toxic effects, being left with bleached and diseased patches (Wells and Hanna 1992). Effects on fish populations were more gradual, taking three or four years before stocks showed sharp declines as a result of destruction of their eggs. The Smithsonian™s Tropical Research Institute prepared a report on the effects of this spill, concluding that full recovery

of the ecosystem might take as long as a century (Luoma 1993).

The worst oil spill in US history occurred on March 24, 1989 in Prince William Sound, Alaska, when the Exxon Valdez, an oil tanker fully loaded with crude oil from the Alaskan Oil Pipeline, foundered on a reef just miles from the port of Valdez. This southern coast teemed with wildlife. Fifty pairs of Bald Eagles nested within the Sound, and 2,500 more lived within the archipelago that extends 900 miles to the southwest. Millions of sea birds and waterfowl in vast colonies nested along the coasts, among them the very rare harlequin duck (*Histrionicus histrionicus*), which had a large breeding population. More than 20 million shore birds and other arctic species pass through the Sound while on migration, and in all, 219 bird species have been recorded in Prince William Sound (Browne 1989). The Exxon spill occurred only two weeks before spring migration.

Sea otters (*Enhydris lutris*) numbered at least 10,000 in Prince William Sound, the largest concentration in the world. Thousands of harbor seals used the islands for feeding and calving. Gray whales fed and migrated through the area, and killer whales had resident pods. Commercial fishermen caught vast catches of salmon, herring and other food fish. The coastline, one of the world's most spectacular, is lined with federal, state and native Alaskan protected lands. Kenai Fjords and Katmai National Parks, Kodiak National Wildlife Refuge and thousands of acres of state and native lands had, until the spill, preserved a magnificent environment almost intact. Rocky beaches alternated with marshes and sheer cliffs studded with sea bird nests.

The Exxon Valdez spilled more than 11 million gallons of crude oil. Almost no action to clean the spill took place for days, due to a lack of preparation on the part of the Exxon Corporation and state authorities, and a lack of agreement about whether to burn off the oil, which the state refused to allow, or to spread chemical dispersants that were feared to cause wildlife mortality. This delay allowed the heavy oil to sink to 90-foot depths and spread hundreds of miles along the coast. By April 10, it covered 3,000 square miles, having spread throughout the region's inlets and coves and southwest 500 miles to Kodiak Island, the haven for the massive Kodiak bear (Ursus arctos middendorffi). The amount of shoreline oiled equaled the distance from Boston to the Chesapeake Bay (Mitchell 1999). Surface oil was 18 inches thick, coating sea birds that landed in it with a lethal film. Many died and sank in open water. By the time the spill ceased spreading, it was found to have fouled 1,500 miles of shorelines and covered 10,000 square miles, an area the size of Vermont (Schneider 1994a).

When cleaning finally began days later, it consisted of high-pressure hosing and wiping rocks. This did not remove the tons of oil that sank deep into the sand, marshes and offshore shellfish beds. Only 15 percent of the oil was recovered through vacuum tubes and booms, while the sunken oil remained a decade later, preventing oxygen in mudflats and wetlands from entering with microorganisms that would break down the oil (Mitchell 1999). The rest has been dispersed by a decade of surf and ocean currents washing it away and has evaporated from the surface.

The toll on wildlife was immediate. Sea birds began washing up on the shore coated with thick oil, some still alive. Sea otters struggled ashore as well, trying to clean their coats while lying on oiled rocks. Crews employed by Exxon picked up dead birds and sea mammals, and by May 12, ABC News reported that 20 tons of dead animals had been collected along 550 miles of soiled beach, of which only two miles had been cleaned. Actual numbers of sea bird mortalities will never be known, but some biologists have estimated that up to 500,000 birds died. Species most affected were common and yellow-billed loons, horned grebes, Pacific cormorants, black-winged and white-winged scoters, common murres, pigeon guillemots and the threatened marbled murrelets (*Brachyramphus marmoratus*). The entire population of common murres in the Barren Islands in Prince William Sound apparently died (Senner 1989), and 40 percent of the region's murres died (Mitchell 1999). Oiled birds and sea otters were brought to special rescue centers, where survival tended to be low.

Sea otters incurred very high mortality and suffered for long periods before they died. Their extremely fine fur collected oil as they swam about the surface, unable to avoid the oil like seals and sea birds who submerged or flew away from the spill. At least 980 carcasses were recovered, but judging from counts carried out during the next few years, almost half the Sound's sea otters died during the spill or from its effects (Schneider 1994). People scouring the

beaches for oiled animals often heard the otters before they saw them. The crude oil's toxic chemicals literally destroyed their livers and other internal organs within hours, causing such pain that they screamed as they died. Some were found dead with mouths wide open as if still screaming. An ABC news program filmed several of the otter pups that were rescued, doll-like balls of fluff who spent hours screeching for their dead mothers. Having no thick layer of body fat to keep them warm, sea otters rely on their dense, layered fur which they constantly groom so that it remains waterproof, with a layer of air to insulate against the cold. When they swam into oil, the otters groomed furiously but succeeded only in distributing oil over their bodies and into their gullets (Wheelwright 1994). Their clumped fur let icy water in, and the crude oil burned their stomachs, sometimes causing acute emphysema, with air bubbles bulging out under the skin of the otter's throat in a grisly necklace (Wheelwright 1994). Many succumbed to hypothermia and sank. When the dead otters were autopsied, a majority of females had near-term fetuses the size of plump rabbits; the western Sound where the oil spill occurred was a "female" area, and they outnumbered males in the otter morgue two to one, with more than 60 percent pregnant (Wheelwright 1994).

Of the several hundred sea otters brought to rescue centers, fewer lived than died, and only a tiny percentage of the total oiled animals were rescued. Most of the surviving pregnant females aborted or had stillborn cubs. Carolyn McCollum was one of the hundreds of volunteers who came from all parts of the country, and even from foreign countries, to help care for oiled animals. In an article for *Wildlife Conservation*, she described seeing these otters snuggling with towels, bunching them up for a pillow or using them to groom their faces. These intelligent animals have been documented as tool users: they use rocks as shell-openers when hand-held or as hard surfaces upon which they bang open shells. Carolyn McCollum (McCollum 1990) took care of one female so ill she was unable to eat, wheezing with emphysema: "I could tell from her abdominal breathing that she was in great pain; her sad eyes followed my movements lethargically and I wished there was something more I could do. About 10:00 p.m. she fell asleep; as I felt her chest to make sure she was still breathing, she pressed my hand to her body with her short forearm and I let her hold it there. Ill and weak, the otters at the center behaved like small babies . . .I held my patient's paw until 4:15 the next morning when she stopped breathing. As the vet came to take her to be autopsied . . . I shuddered to think how many more animals would go through the same ordeal.fl

Long-term damage to Prince William Sound started to become apparent by 1994. Marine ecological systems had suffered serious effects. Some species of water birds, especially harlequin ducks, ceased to reproduce in the Sound (Schneider 1994a). Although salmon catches initially rose in 1990 and 1991, as did herring in 1991 and 1992, the catches later plummeted (Schneider 1994a). In the spring of 1994, Alaska officials closed the Sound's herring fishery because there were too few fish. The herring, which are the keystone species in Prince William Sound, fed on by sea birds, mammals and humans alike, died from disease which manifested in skin lesions, perhaps caused by sub-lethal effects of oil (Mitchell 1999). By 1999, herring had still not recovered, and a population estimated at 120,000 tons prior to the spill fell to 40,000 tons (Mitchell 1999). The oil remaining in the water has apparently affected a variety of wildlife, preventing the recovery of virtually every species except the Bald Eagle (Mitchell 1999). Populations of sea otters, harbor seals, killer whales, pink salmon, herring and many sea birds have not recovered. Harbor seals plummeted from 2,000 to only 900 in the Sound. For seals and other fish-eating marine mammals, there are apparently not enough fish to eat, and recovery of fish populations seems to have been slowed by the remaining oil, which kills young fish even at very low concentrations (Mitchell 1999). Fishermen were awarded $5 billion for their losses by a US District Court in 1994, when a jury decided that the captain of the Exxon Valdez had acted recklessly (Schneider 1994b), but they have yet to be paid by Exxon (Mitchell 1999). This company, now merged with Mobil Oil Company, continues to earn approximately $8 billion per year, yet it refuses to settle this claim, and fishermen now earn only half their pre-spill income.

The spectacular Steller's eider (*Polysticta stelleri*) was once an abundant bird of Alaskan and Russian arctic waters. These striking waterfowl formerly nested on the Alaskan Peninsula and the Yukon Delta to the Canadian border, but in recent years they have disappeared from Alaska except the western Arctic coastal plain. Worldwide, their population has declined 50 percent, and they have been listed on the Endangered Species Act as threatened. The oil from the Exxon Valdez and other spills may have spread throughout the region in miniscule amounts that gradually became lethal to these birds. Other oil spills have occurred in Alaska since 1989, including 100,000 gallons spilled in

1997. Some oil tankers have illegally dumped or spilled oil and oily ballast.

Some good came from this massive oil spill. The state of Alaska purchased 650,000 acres of land within the archipelago for wildlife protection with $900 million from the Exxon settlement. Old-growth forests, providing key habitat for threatened species, have been deeded by native corporations for permanent protection from logging in conservation easements, and 61 trout and salmon spawning streams will be purchased (Mitchell 1999). A fund of $140 million, which began in 1994 from Exxon payments, will be available for spending on research, monitoring, fisheries applications and habitat protection (Mitchell 1999). The corporation that monitors the movements of oil tankers through Prince William Sound has adopted new procedures and equipment for fighting future spills, but only three of 28 tankers that use the Sound have double hulls (Mitchell 1999). Double hulls, or an inner hull protected by an outer one, greatly reduce leakage in a collision. It is estimated that 60 percent or less of its oil would have spilled had the Exxon Valdez been equipped with double hulls (Mitchell 1999).

Other oil spills around the world have involved heavy wildlife mortality as well. Jackass or African penguins (*Spheniscus demersus*) once numbered more than 1 million birds in colonies along the coasts of South Africa and Namibia, but their numbers have been in decline for decades. They have declined to 180,000 birds Œ a result of multiple oil spills, destruction of breeding habitat for extraction of guano, food shortages as a result of overfishing by commercial purse seiners, feral cats on their nesting grounds and disturbance by humans causing them to abandon nests (BI 2000). In June 1994, a large spill near Cape Town killed thousands of these penguins (Associated Press 1994). The species was classified as near-threatened by BirdLife International in 1994 (Collar *et al*. 1994), and it has suffered population declines ever since. In Threatened Birds of the World, BirdLife International classifies the species as vulnerable, a more threatened category that indicates serious decline.

In the summer of 2000, a large oil spill occurred within feet of their prime breeding ground off Cape Town. Professional bird rescue organizations, experts and volunteers from around the world converged on the area within a few days. This was the most massive bird rescue in history and saved the lives of over 38,500 adult penguins by placing all adults that could be caught in a giant warehouse and holding area in Cape Town (Associated Press 2000a). Oiled birds were cleaned and fed, while oil-free birds were held to prevent them from becoming oiled in the spill. Most were caught on land attending to chicks and incubating eggs, as this was the height of the breeding season. More than 19,000 birds were shipped 500 miles up the coast and released (Associated Press 2000a). By the time they returned to Cape Town, a swim that was monitored on the Internet, the spill had been cleaned up. The rescuers claimed the unprecedented survival rate of 90 percent. The unfortunate casualties were abandoned chicks and eggs. In spite of the large numbers of birds saved, the entire generation of young were lost, and an unknown number of oiled adult birds died at sea.

In the Siberian tundra, a delicate frozen ecosystem with a thin layer of soil covering permanently frozen ground, known as permafrost, is extremely vulnerable to damage from oil spills. Oil exploitation over the past few decades has resulted in many spills that permanently scarred the land. The most recent, in the fall of 1994, spilled approximately 33 million gallons of oil, three times the total spilled in Alaska, polluting three major rivers. Long-term effects will not be measured for years, but the immediate effects have been massive fish kills in the Kolva, Pechora and Usa Rivers of the northeast (Filipov 1994).

Large oil spills, however dramatic, do not constitute the majority of oil spilled in oceans. They may make up only about 12 percent (Wells and Hanna 1992). Forty-five percent of the oil that is becoming pervasive in ocean ecosystems comes from the routine flushing of tanks and bilges of ships at sea, and one-third comes from regular leakages at land-based operations such as refineries (Wells and Hanna 1992). Floating tar balls and dissolved light oil continue to cause mortality and ecological damage, destroying the waterproofing of birds' feathers and settling on coral reefs. As marine biologist Dr. Sylvia Earle, former chief scientist of the National Oceanic and Atmospheric Administration (NOAA), noted in *Sea Change: A Message of the Oceans* (1995): "Nets dragged through the sea anywhere are likely to come up clogged with tar balls, beaches in the most remote areas are fringed with an oily scum or lined with sticky gobs of oil; over the surface of much of the ocean a rainbow-hued film glistens with deadly beauty

at one time or another." Since 1970, 50 major spills the size of the *Exxon Valdez*'s have happened worldwide (Mitchell 1999).

The ingestion of lethal oil compounds, whether within days or weeks after a spill or from residues remaining years afterward which enter the food chain, is the key cause of mortality for the millions of sea creatures that die in oil spills. Research conducted by Dr. Daniel W. Anderson of the University of California at Davis revealed that only 12 to 15 percent of Brown Pelicans rescued in oil spills survived for two years (Kopytoff 1996). The greater the amount of oil ingested, the higher the death rate.

A remarkable discovery in the late 1990s has yet to be aggressively pursued as a means of cleaning up spilled oil. A barber who watched the news of the Exxon Valdez spill noted that the sea otters died in large numbers as a result of the extreme absorbency of their fur and their ingestion of oil while grooming. He began collecting human hair from his barbershop and testing it for absorption of oil. It proved remarkable in its ability to suck up large amounts of oil when contained in mesh nylon bags, leaving almost no oil in the water. He approached NOAA and showed them his findings. They tested the process and confirmed his results. Although this was widely publicized on television and in newspapers, little has apparently been done to place this very simple, low-tech process into real situations by encouraging oil tankers and land-based oil pollution teams to store large amounts of hair for this purpose. NOAA tests determined that the oil absorbed by the hair could easily be recovered by squeezing the bags into holding tanks.

In the wake of the Exxon Valdez spill, Congress enacted the Oil Pollution Act of 1990, which requires oil tankers operating in US waters to pay large penalties and carry massive insurance liability for spills. Civil penalties range up to $1,000 per barrel discharged. Within a month of the passage of this law, 20 oil companies created two new organizations: the Marine Spill Response Corporation and the Marine Preservation Association (Earle 1995).

The need for such protection from catastrophic spillage has been apparent since the early 1970s when these supertankers began to ply the world's oceans loaded with 200,000 tons of crude oil, built so cheaply they had virtually no protection against splitting apart if they ran aground. The dangers of these ships were dramatically portrayed in the 1974 book, *Supership* (Mostert 1974). More than 25 years of oil spills later, stringent regulations still have not become the rule of the sea. An international agreement requires all oil tankers built after July 1996 to have double hulls, but not all countries are complying. Congress put off the effective date of an amendment requiring replacement of single-hulled ships with environmentally sound double hulls to 2015**,** and even this date may be postponed.

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Extinct Species
The Yangtze River (Baiji) Dolphin

The baiji, a freshwater dolphin species weighing 220 to 355 pounds, was historically found throughout the Yangtze River and its surrounding lakes and tributaries. Like other river dolphins, they had long, narrow beaks and poor vision. Because they lived in extremely muddy waters, baiji relied on echolocation to locate mates and food. This dependence kept the ancient species alive for over 20 million years, but recently, human exploitation took its toll. The last official baiji sighting was in 2004, when only two individuals were observed. Sadly, a 2006 expedition revealed no sightings, and the species was deemed fifunctionally extinct.fl

The exponential growth of the Chinese population posed a variety of threats to the survival of the baiji. In 1975, the species was first listed as a Protected Animal of the First Order by the Chinese government. Chinese officials designated protected areas for the baiji; however, the areas proved insufficient and did not encompass the full length of its habitat. Futile captive breeding efforts were also attempted for years.

In the 1990s, electrofishing killed a large number of the dolphins, and overfishing depleted their prey. Additionally, the lengthy construction of the Three Gorges Dam obstructed natural migration patterns, isolated groups of individuals, and impaired breeding opportunities. Along with this industrialization came more ship traffic, which increased the likelihood of dolphin collisions with boat propellers and ships.

Furthermore, the activity in the river created anthropogenic noise that impeded the baiji™s ability to locate food and mates. Water pollution and entanglement in fishing gear are also blamed for the species™ decline. The baiji, accustomed to a pristine and rich environment, was no match for the increasing pollution and congestion of its home.

While the baiji was listed as an endangered species under the US Endangered Species Act and as a critically endangered species on the IUCN Red List of Threatened Species, it was unable to recover due to a lack of information, growing threats and its small population size. Today, the Yangtze River has lost its top predator, which will have a devastating effect on local ecosystems.

Endangered Species Handbook

Madagascar and other Islands:

Madagascar and other Islands

Madagascar

Imagine an island more than 1,000 miles long in a blue tropical ocean. Forests cover vast areas, interspersed with swamps where crocodiles 8 meters long lie in wait to prey on pygmy hippopotamuses. Thousands of giant tortoises with shells 4 feet across lumber about. In the forests and in dryer parts of the island live some of the strangest primates to have ever existed on Earth. Some 45 species of these lemurs live throughout the island and range in size from the world's smallest primate, weighing about 1 ounce, to a lemur the size of a Gorilla (Tattersall 1993).

Huge white birds plod along forest trails and through savannah grasses. Many kinds of these birds inhabit the island. The largest resembles an Ostrich, but is far more massive in build, weighing 1,000 pounds (Feduccia 1996). It stands 10 feet tall and lays 20-pound eggs, 13 inches long (Feduccia 1996, Greenway 1967). More than 100 other kinds of tropical birds that exist nowhere else fly in forests and deserts and wade in still marshes.

Primitive hedgehog-like mammals, called tenrecs, scurry in forest underbrush. One type of tenrec lives in cold mountain streams, swimming with webbed feet and flattened tail, while another has spines like a porcupine and stripes down its back like a skunk. It communicates with its young by vibrating its spines.

Hundreds of kinds of amphibians and reptiles inhabit forests, aquatic environments, savannahs and drylands. Frogs of every imaginable color and pattern leap in green shadows. Chameleons, some brilliantly colored, and others shades of mottled brown, creep invisibly about. The largest, 2 feet long, can capture mice and birds, while the smallest, measuring only 1.5 inches, feeds on insects (Amos 1980). Tortoises with shells adorned in delicate yellow sunburst patterns inhabit shrub and deserts.

Plants exist in unparalleled variety, a botanical paradise. Relicts of species long-extinct on mainland areas--tall tree ferns, palms, red-flowered flame trees, massive deciduous and rainforest trees, giant tamarinds and aloes, desert oddities, and baobabs of many sizes--grow in even the driest parts of the island. Orchids in a rainbow of colors bloom among the deep green rainforests. Waterfalls abound, cascading down tall cliffs into rivers and lakes. Along the west coast, a dry deciduous forest stretches the length of the island**.** The central highlands are a mosaic of woodland and savannah, while the eastern regions are covered in dense, humid rainforest. In the extreme south, a desert environment prevails, harboring *Didierea*, strange cactus-resembling plants that form long, spiny, twisted shafts rising 30 feet into the air. An impenetrable wilderness of limestone spikes and sharp rocks dominates the far north. Rare birds and lemurs find refuge in this craggy landscape and feed in oases watered by meandering streams.

Flightlessness, fearlessness, gigantism, dwarfism, and survival of ancient species all occurred in this evolutionary laboratory. That such a large land mass went uninhabited by humans for so long is truly remarkable. Nowhere else on the planet has such a large land area remained isolated for such a prolonged period, allowing a flowering of diverse life forms to flourish and adapt to the island's many habitats and terrains in this mild, tropical climate. Such is the history of the island from Madagascar in 400 A.D., a century before the arrival of the Malagasy people of Asia. Had humans reached Madagascar earlier, it might not have evolved its diverse, yet vulnerable, fauna and flora.

How such an extraordinary diversity of animals and plants inhabits Madagascar is tied to its geological history. Some 160 million years ago, when Africa, Australia, New Zealand and South America were united in the super-continent Gondwana, Madagascar was attached to eastern Africa and what is now peninsular India. Dinosaurs, giant turtles, crocodiles, primitive mammals, reptilian birds and lizards roamed on this massive land mass. Gondwana gradually broke apart as a result of movements of tectonic plates covering the Earth's crust. For many millions of years, India and Madagascar formed a mini-continent. Then, about 88 million years ago, they split along Madagascar's east coast, and peninsular India moved northward toward Asia (Garbutt 1999, Tyson 2000).

Paleontologists have only recently discovered that Madagascar was home to dinosaurs and other primitive animals quite unlike those found in other parts of the world. The oldest known species of dinosaur, dating back 227 million years, may be the ancestor of all dinosaurs (Flynn 2000). One dinosaur had teeth that were clove-shaped (Stenzelt and Thiessen 2000). Seven species of crocodiles inhabited Madagascar from the Cretaceous period onward, including a pug-nosed vegetarian species (Flynn 2000). About 65 million years ago, the last dinosaurs died out, concurrent with their extinction throughout the world. Some native plants and animals survived from the time when Madagascar was part of Gondwana. Giant tortoises, crocodiles, boas, tenrec ancestors and possibly an early form of elephant birds may have lived on the super-continent, although most ornithologists are certain that the ancestor of the elephant bird flew to the island and became flightless (Feduccia 1996). Plants of many kinds, virtually unchanged from their ancient forms, grow on the island.

Immigrant animals arrived during the millennia from many sources. Because Madagascar separated from India and Gondwana long before the evolution of the prosimians that were the ancestors of the lemurs, these primates must have come from mainland Africa, where their close relatives, bush babies and galagos, survive today. Some scientists believe they might have traveled over a land connection that existed between Africa and Madagascar at some point (Tyson 2000). Others dispute that there ever was such a land bridge and maintain that they arrived by sea, perhaps sheltering on large mats of floating vegetation or clinging to uprooted tree trunks that swept down mainland rivers to the sea and washed up on Madagascar's shores. Few modern mammals of Africa, whether baboons, monkeys, gazelles, antelope or other hoofed mammals, reached Madagascar. The hippopotamuses must have originated in Africa, but how they came to the island is another mystery.

Over many millennia, a blossoming of evolution occurred in this mild, tropical climate of Gondwandan and immigrant species, radiating into entire new families and creating a flora and fauna of great diversity unlike any in the world. Birds, bats and insects flew or were blown to the island by wind currents and storms from Africa and Asia. No large carnivores arrived, however. The largest mammal predators are relatives of mongooses, primitive viverrids. Grazing and browsing roles were filled by hippopotamuses, land tortoises, lemurs and elephant birds.

Human Settlers Invade Paradise

About 500 A.D., immigrant people from Asia, most probably Indonesia or Malaysia, arrived on Madagascar's shores in hand-hewn canoes, bringing domestic animals with them. They began clearing forests and burning them for farmland, and turned lakes and wetlands into rice paddies. Cleared land produced crops for only a few years until the thin soil became sterile. Farmers then moved on to other parts of the forest, in this slash-and-burn agriculture. At some point, African herdsmen colonized the island, bringing zebu cattle, which crowded out wildlife (Tyson 2000). Gradually, abuse of the land eroded the soil in the central highlands to bare earth, pocketed and gouged by deep gullies and cavernous holes. This region had harbored a great variety of lemurs, along with a wealth of birds, reptiles and unique plants. Throughout the island, wildlife declined as habitats disappeared, isolating animals in smaller and smaller patches of forest and wetlands. The large lemurs, tortoises and elephant birds were avidly hunted.

Within 600 years of the arrival of the Malagasy, extinctions claimed many native animals. Several elephant bird species, the larger lemurs and many native plants vanished. Two kinds of pygmy hippos inhabited the island. The Madagascar Hippopotamuses (*Hippopotamus lemerlei*), an amphibious species, and *Hippopotamus madagascariensis*, a forest species, were both about 6.5 feet long and 2.5 feet tall, smaller than the Common Hippopotamus of Africa, which is about 10 feet long (Tyson 2000). From genetic and anatomical analysis, both seem to have evolved from the latter species (Tyson 2000). The hippos had been widely distributed and very common prior to the arrival of the Malagasy (Dewar 1984). Their bones have been found with marks indicating that they had been butchered (Tyson 2000). Both died out long before Europeans arrived. The native crocodile, whose large bones have been found, is

believed by some scientists to represent large specimens of Nile Crocodiles, the species native today (Tyson 2000). It is thus possible that the crocodile survived. A large mongoose-like viverrid, *Cryptoprocta spelea*, and a very unusual aardvark-like animal, *Plesiorycteropus madagascariensis*, died out at an early date (Dewar 1984).

Prior to the arrival of humans, elephant birds had been abundant in most parts of the island, as attested by the prevalence of their bones. There were two genera, and from six to 12 species of these birds (Tyson 2000). It is likely that the flightless birds fell prey to the primitive weapons of the Malagasy and were crowded out of their habitats by livestock (Tyson 2000). The last to die out was the Great Elephant Bird (*Aepyornis maximus*), which may have survived until recent times by retreating to remote swamps. Dr. Alexander Wetmore of the Smithsonian Institution examined bones of a Great Elephant Bird unearthed in archeological excavations in the 1960s. He was amazed by their size: "The incredible femur, or thighbone, of this ponderous bird is by far the largest I have ever seen" (Wetmore 1967). Estimated to weigh at least 1,000 pounds, more than three times the weight of an Ostrich, it produced eggs larger than any dinosaur's, with a capacity of 2 gallons (equivalent to seven Ostrich eggs), 180 chicken eggs or 12,000 hummingbird eggs (Bradbury 1919, Fuller 1987). When one was X•rayed, the bones of an embryo three•fourths developed were revealed (Wetmore 1967). Something had interrupted the embryo's growth and frozen it within the eggshell for hundreds and perhaps thousands of years (Wetmore 1967).

Despite its fearsome size, the Great Elephant Bird lacked a hooked beak for tearing prey and was plainly not a predator (Wetmore 1967). Its large, clawed feet may have helped it defend itself against the small native predators but were not enough to protect it from Malagasy arrows. Its short legs prevented it from running as fast as its relative, the Ostrich, but it may have been quite agile when chased. This vegetarian bird browsed and cropped plants, able to reach with its long neck to the lower branches of trees (Wetmore 1967). By the mid-16th century, when Europeans had managed to establish a foothold in Madagascar, the new French Governor, Sieur Etienne de Flacourt, wrote in 1661 that the Great Elephant Bird was still found in the south of the island, "seeking the most deserted places" to avoid human hunters (Tyson 2000). Villagers of Antandroy told of an Ostrich-like bird that was difficult to catch, according to Flacourt (Tyson 2000).

The exact date this giant bird became extinct is not known with certainty. Alan Feduccia (1996), an eminent paleo-ornithologist, asserts that elephant birds of many species were still widespread in the 10th century but gradually disappeared as a result of human activity. He cites an account by a French merchant sailor in 1848, who visited Madagascar and saw the shell of the Great Elephant Bird; he was told that it belonged to the chief and that the bird that produced such eggs "is still more rarely seen" (Feduccia 1996). Some authorities estimate that it died out in the mid-17th century, although there is no proof that any European ever saw one of these birds (Tyson 2000). It has been suggested that Europeans were responsible for the bird™s extinction by hunting and destroying its habitat (Quammen 1996). But Thomas Brooks (2000) of the Center for Applied Biodiversity Science, Conservation International, asserted in a list of extinct birds in *Threatened Birds of the World* (BI 2000) that all the elephant birds had disappeared by 1500. In a bizarre footnote to this species' epitaph, an *Aepyornis* egg washed up on Australia's western coast in 1995. No conclusive explanation for this strange event has been put forth, although it is likely that it became unearthed from long interment by rains, and washed out to sea. Much less is known of the other species of elephant birds, which existed in a variety of sizes down to a chicken-sized species.

Lemur-like primates once lived on many continents, but nowhere had they evolved into such a great variety of species. When the Malagasy people arrived some 1,500 years ago, lemurs occupied every habitat, even marshland. A species as tall as a man must have startled the Malagasy immigrants, giving rise to legends that these animals had superhuman powers. The first French naturalists were told by the Malagasy that these primates were thought to be the ghosts of sacred ancestors of man, inspiring the genus name Lemur, the word for ghost in Latin. The Malagasy considered some lemurs sacred and punished anyone who harmed them, but most species were feared as evil demons and were killed on sight.

From their arrival on Madagascar, the Malagasy hunted the larger species of lemurs, almost all of which are now extinct. Archaeological excavations show that they formed a staple in the immigrants' diets. Such diggings have

unearthed the skulls and bones of long•extinct lemurs in early Malagasy jars and kitchen middens; their heads had been split by ax-heads made from an extinct flightless bird (Jolly 1980).

In the centuries following colonization by the Malagasy immigrants, some 15 species of lemurs of eight genera became extinct (Mittermeier 1997). These extinct lemurs were, for the most part, far larger than surviving species and had evolved to fill many ecological niches. Three *Megaladapis* lemurs weighed between 90 and 170 pounds and moved slowly through the trees, feeding on foliage (Tattersall 1993). Another species, *Archaeolemur*, was about the size of a female baboon and lived on the ground (Tattersall 1993). Two *Palaeopropithecus* species weighed between 90 and 130 pounds and were sloth•like tree dwellers with flexible bodies (Tattersall 1993). These extinct lemurs had evolved many unusual means of movement and locomotion that have no parallels in living species of lemurs.

Largest of all, the massive 400•pound *Archaeoindris* was apparently a ground•dweller, moving on all fours; many of its anatomical characteristics are unlike any living primate (Tattersall 1993). One entire lemur family, Archaeolemuridae, was obliterated. In this family were many species of lemurs weighing between 35 and 55 pounds; they were powerfully built and short•legged (Tattersall 1993). The heaviest lemur surviving today, the Indri (*Indri indri*), weighs only about 15 pounds (Tattersall 1993). These lemurs had survived for millions of years, and their extinctions were indeed a major biological loss to the planet. According to primatologists, the surviving lemurs resemble the very earliest primates from the Eocene (Tattersall 1993). Like prosimians in Africa and Asia, but to a far greater degree, lemurs have a highly developed sense of smell. Some species have long, fox-like noses (Preston-Mafham 1991). Genetic analysis of their DNA has revealed that all lemurs are descended from a single ancestor that probably arrived from Africa about 60 million years ago (Garbutt 1999).

The Giant Aye-aye (*Daubentonia robusta*) lemur was somewhat larger and 2.5 to 5 times heavier than the surviving Aye-aye (see below), but in other respects was very similar (Garbutt 1999). It is known from subfossil remains found in southwestern Madagascar (Nowak 1999). The date of its disappearance is unknown but may be fairly recent.

Archaeologists have uncovered remains of a massive bird of prey, the Malagasy Crowned Eagle (*Stephanoaetus mahery*), which undoubtedly preyed on lemurs (Feduccia 1996). In fact, at one locality the diet of this eagle, based on the bones of eagles and lemurs found together, contained at least 80 percent primates, including specimens weighing up to 26.5 pounds (Feduccia 1996). Remains of another large eagle of the genus *Aquila* have been discovered, and it, too, preyed on large lemurs and became extinct after the arrival of the Malagasy. These extinct birds preyed on smaller lemurs as well, including some species still surviving (Feduccia 1996). A bird of prey flying overhead still elicits fear in lemurs, causing them to seek cover. Neither of the two remaining species of eagles on Madagascar preys on lemurs, but two hawk species have been seen preying on young lemurs (Garbutt 1999).

In addition to the Giant Elephant Bird, the large Snail-eating Coua (*Coua delalandei*), a member of the cuckoo family, became extinct. The last specimen of this large, slate-blue bird was taken on an islet off the east coast, Ile Sainte-Marie, in 1834 (Morris and Hawkins 1998); reports by observers who claimed to have seen the bird were recorded as late as 1930 (Fuller 1987). The causes of this bird's disappearance, and even its exact range, remain obscure (Langrand 1990). Many specimens of this bird were taken before its extinction and kept in museums in Leiden; London; New York; Paris; Philadelphia; Tananarive (Madagascar); and Cambridge (Massachusetts) (Fuller 1987). The long feathers of this bird were highly valued by the Malagasy, and hunting may have reduced its numbers to a critically low level (Fuller 1987). It is also possible that the many birds killed for zoological specimens may have pushed this already rare bird to extinction, since its distribution may have been limited to the tiny Ile Sainte-Marie. No reliable record exists of its presence on the main island of Madagascar, but there is hope that it might be found in lowland forest near the Bay of Antongil (Morris and Hawkins 1998). Ten closely related species of couas survive, all smaller than the Snail-eating Coua.

The Biological Wealth of an Impoverished Country

The Madagascar of today is still a remarkable place, although about 90 percent of the forests, including almost all lowland rainforests that were richest in wildlife, were destroyed (Mittermeier *et al.* 1999). Some 33 lemur species survive, along with all but one species of tenrec, various mongooses and their relatives, more chameleons than any other country, several hundred kinds of frogs and reptiles, and thousands of endemic invertebrates and plants. Madagascar has no native fish, but many introduced species. Its fauna and flora represent many extremely unusual and unique examples of evolution (Mittermeier *et al.* 1999). This island is considered one of the five most biologically important areas in the world; its primates are the world's highest priority for conservation (Mittermeier *et al.* 1999).

The Biological Wealth of an Impoverished Country: Forests and Plants

Madagascar has one of the richest floras in the world. Eighty percent of its plants are found nowhere else (McNeely *et al.* 1990, Preston-Mafham 1991). The diversity of plants that survived almost 2,000 years of forest destruction continues to astound biologists and conservationists. Tropical trees with fruit growing on their trunks (various species of the genus *Tambourissa*) are native, as is a cactus (*Rhipsalis*), related to American species, that lives in the rainforest. A tree, *Symphonia*, which has leathery leaves and red-and-white striped flowers that look like peppermint candies (Morell 1999), also survives. The Flame Tree (*Delonix regia*), which produces cascades of red flowers, is grown around the world for its beauty, but few realize that it originated in Madagascar (Preston-Mafham 1991). Miraculously, many endemic plants have survived the fires and tree cutting that have destroyed much of the island. One mountain chain has 150 endemic vascular plants, a very high number (Preston-Mafham 1991). They are among the 7,300 to 12,000 species of plants native to Madagascar (Preston-Mafham 1991). Its flowering plants make up 20 percent of all the plants in the African region (McNeely 1990). At least 191 botanical families, a very large number for a relatively small area, evolved from ancestor species (Preston-Mafham 1991).

Some 2,000 years ago, the eastern rainforest stretched in a band 100 miles wide from north to south, covering 27 million acres (Tyson 2000). Ninety percent of the plants were endemic, with a profusion of unusual ferns, some types growing on tree trunks; wild ginger, with delicate purple flowers; bamboos; and far more orchids than in an African rainforest (Preston-Mafham 1991). An early traveler described the woods as so dense that there was a fideep gloom: below the canopy at mid-day (Tyson 2000). Rainfall must have been greater and general climate more humid than at present as a result of these extensive rainforests. In the montane ridges, huge tree ferns, mosses and lichens cover the ground and hang from tree branches (Preston-Mafham 1991). Over the centuries, Malagasy burned many portions of the rainforest, especially in the south. Few tall trees remain in the rainforest today, although at one time there must have been many giants. During the 19th century, a palace was built for a woman ruler, centering on a 130-foot tree that had been carried by 5,000 laborers from the eastern rainforest (Tyson 2000). The palace was destroyed by an uprising in the 1850s. About this time, Malagasy dragged a tombstone through the forest, cutting 25,000 trees just to make a path (Tyson 2000). Early decrees banned cutting of virgin forest, with severe penalties, in the 19th century, but these were largely ignored (Tyson 2000).

About half of the island's forests had been cut by the late 19th century, and intensive cutting continued in the 20th century (Tyson 2000). The prime lowland forests throughout the island and three-fourths of the rainforest were cleared by the French for growing coffee and other crops in the first three decades of the century (Tyson 2000). The rainforest was heavily logged between 1950 and 1985, with 275,000 acres cleared and burned each year (Tyson 2000). The northeast Masoala Peninsula still retains sizeable areas of unlogged rainforest, but the southern region has been reduced to fragments of the original unbroken expanses. The remnants tend to be on sharp ridges where soil is poor and access difficult. For example, Ranomafana, a recently declared national park, straddles such an escarpment. Even so, many of its trees had been removed prior to its protection (Tyson 2000). What was once a closed-canopy, humid rainforest is now far dryer and cooler, with many openings among the trees, and some illegal logging continues (Tyson 2000). Still, botanists from the Missouri Botanical Garden, who were conducting a census of the trees in this park, counted 37 families of trees with 105 species in a 1-hectare plot (Tyson 2000). Outside the park's boundaries, rainforest is still being cleared and burned by the Malagasy, many of whom believe that their wealth lies in the amount of land they clear (Morell 1999).

The western dry, deciduous forest lies in the shadow of eastern mountains, which block moist ocean air currents (Preston-Mafham 1991). Trees do not attain heights of more than 80 feet, but many types of plants have adapted to this environment. Liana vines grow among the trees, and dead leaves carpet the forest floor. Large tamarind trees grow along rivers, and baobabs grow in plateaus (Preston-Mafham 1991). Beautiful orange bell flowers of the *Ipomoea carnea* plant burst into bloom during the short rainy season. As with the eastern rainforests, the once continuous stretches of deciduous forests have been largely destroyed, replaced by grasses able to survive in the eroded or bare soil.

Throughout the island, most deforested areas fail to regenerate into second-growth forests, even when left fallow, because Madagascar lacks vigorous colonizing trees that can quickly protect cleared ground and prevent further erosion (Preston-Mafham 2000). Cleared hillsides become covered in non-native grasses and exotic South American trees (*Psidium cattleyanum* and *Psidium guajava*) or plantations of eucalyptus, which inhibit the establishment of native seedlings (Preston-Mafham 1991; Sayer *et al.* 1992). Only if soils are rich and remnants of original forest are nearby will native forests regenerate. Unfortunately, the original forests and their native wildlife are lost permanently, and even regeneration cannot take place without a cessation of the slash-and-burn cycle, known as fitavyfl by the Malagasy (Preston-Mafham 1991). Moreover, foreign logging companies have obtained logging concessions on most of the unprotected remnants of native forest. Tree cutting consumes some 7.8 million cubic meters of wood per year, of which 7 million cubic meters is for fuel and charcoal (Sayer *et al.* 1992). Valuable timber trees have been logged to extinction in most of Madagascar. The two native species of ebony trees of the genus *Diospyros* have been heavily logged for centuries, and few large trees are left (Sayer *et al.* 1992). The understory plants, such as tree ferns, are also exploited, dug up to sell as potted plants (Sayer *et al.* 1992).

The net result of this logging and burning, especially in the barren central highlands, is the loss of "a priceless reservoir of plant and animal species, replaced by one of the most impoverished forms of vegetation on the planet" (Preston-Mafham 1991). Many species of trees and other plants are highly endangered. Madagascar is one of the world's 12 "hot spot" areas of tropical forests, having a high percentage of endemic species which are under great threat (McNeely *et al.* 1990). Since an estimated 94 percent of Madagascar's trees are endemic, and many occupy very restricted ranges, they are highly vulnerable to extinction. Further research will likely reveal even more threatened species. Some authorities believe that even this rich plant diversity must represent only a fraction of the "vast original flora," since 80 percent of the vegetation and forests is gone (Ayensu *et al.* 1984). The *1997 IUCN Red List of Threatened Plants* includes 19 species of plants that may have recently become extinct, and an additional 287 species that are threatened with extinction (Walter and Gillett 1998).

Resident since the days of the dinosaurs, trees of a family of primitive pines, Podocarpaceae, grow on the island. The family is represented by species in other parts of the world that were part of Gondwana, from South America west to Southeast Asia. Madagascar has a number of native Podocarps, of which four endemic species or varieties are listed by the *IUCN Red List* as either Vulnerable or Rare (Walter and Gillett 1998). At least 26 genera of plants are

native to Madagascar and South America, but not to Africa, and are believed to be remnants from Gondwana (Preston-Mafham 1991). Another one of these, Madagascar's national tree, the Traveller's Tree (*Ravenala madagascariensis*), is a palm-like species of the banana family (Musaceae). Its closest relative of the same genus grows in Brazil and Guiana, but not in Africa (Preston-Mafham 1991). This tree has leathery petals covering its pollen and nectar and is a key food source for both bats and lemurs. In return, it depends on lemurs for pollination. Lemurs feed on the nectar, getting their noses covered with pollen in the process. They are so fond of the nectar that they travel miles to find another Traveller's Tree, still carrying the nectar on their noses and, unknowingly, pollinate the next tree they feed on (Attenborough 1995).

A plant of the Winteraceae family that has been growing on the island for 30 million years was recently seen again after a period of 90 years (Hsu 1997). This tree, *Takhtajania perrieri*, has many primitive features, such as a lack of vessels to move water and minerals; like many of Madagascar's relict species, it once grew on much of continental Africa, but long ago disappeared there (Hsu 1997).

Madagascar has more palms (Palmae family) than all of Africa (Preston-Mafham 1991). Many are in danger, however. The *IUCN Red List of Threatened Plants* lists 148 native species in various categories (Walter and Gillett 1998). The Big-leaf Palm (*Marojeya darianii*) was chosen by the Species Survival Committee of the IUCN to be one of 12 critically endangered species highlighted at its 1988 General Assembly in Costa Rica. This species was only discovered in 1982 and is confined to a single swamp in the northeast (Prance 1990). An agricultural program to raise rice cleared half its habitat, and then failed. This huge-leafed palm has been over-harvested as a source of heart-of-palm, a commercially valuable product (Prance 1990). Huge palms are felled for their inner pith to supply this gourmet market. The majority of palms grow in the eastern rainforests in a great diversity of size. Two threatened palms, *Dypsis hildebrandtii* and *Dypsis louvelii*, are miniature delicate-fronded palms only 3 feet high (Preston-Mafham 1991). Others, like the threatened *Ravenea glauca*, are majestic giants with long, straight trunks rising 50 feet or more to a luxuriant crown. Palms do not often survive the fires set by the Malagasy to clear land, disappearing from one area after another (Preston-Mafham 1991).

On the entire continent of Africa, only one species of baobab tree is native, while seven species are found in Madagascar (Preston-Mafham 1991). These strange-looking trees have wide trunks that taper to a narrow crown, looking like upside-down trees. Some baobabs grow to immense size. One famous specimen measures 46 feet around the base of the trunk (Preston-Mafham 1991). Another species, *Alluaudia ascendens*, grows in the southern desert. Although it can reach a maximum height of 16 feet, it is usually far smaller (Preston-Mafham 1991). Each of the seven species has a slightly different shape and size, but all have gray bark that resembles unwrinkled elephant skin. Baobabs are extremely important to both wildlife and humans. The Malagasy cut holes in their massive trunks and hollow out the spongy pith where water accumulates. In the dry south, these trees become wells, and villagers set ladders against the trunks, climb to the hole cut from the trunk, and lower buckets into the pool of water. Natural holes in baobob trunks and branches provide important nesting holes for birds and lemurs. These trees are fire-resistant, and fortunately, they are worthless as timber because of their soft, pulpy cores. For this reason some stands of thousands of huge, very old baobabs remain in parts of the island. Because of the heavy livestock grazing, few young baobab seedlings can survive, however, and botanists believe that the spectacular vistas of these behemoths will gradually disappear (Preston-Mafham 1991).

One very strange group of Madagascan plants native to dry areas has nine species in the same genus, *Pachypodium*. These succulent plants lose their leaves at the onset of the dry season and have evolved into a variety of forms, all with gray, smooth bark. Eight of the nine species are threatened with extinction, according to the *IUCN Red List of Threatened Plants* (Walter and Gillett 1998). One of these, the endangered *Pachypodium decaryi*, is native to Antananarivo, the "tsingy" limestone crags of the northwest. Its smooth, silvery trunk resembles a large inverted turnip, fat at the base and tapering upward, topped by a messy mop of thin, straggly branches (Preston-Mafham 1991). It bears large, white flowers during the dry season. Its main population occurs in the Ankarana Special Reserve, which bans burning (Preston-Mafham 1991), but has recently been invaded by hordes of miners who are clearing vegetation to search for sapphires (Morell 1999). Other Pachypodiums have equally bizarre

shapes, such as the bulbous *Pachypodium rosulatum*, which resembles a huge gourd sprouting long, thin shafts from which its bright yellow flower bloom. The rare *Pachypodium densiflorum*, with the appearance of a domestic jade plant run amok, has a mass of short, gray branches sprouting from a squat gray base. All these plants are highly susceptible to fire. Ken Preston-Mafham, in *Madagascar: A Natural History*, describes the threat of "incessant brush fires which ravage the length and breadth of central Madagascar during the dry season. Within hours, hillsides which had been decorated with colorful rock gardens of rare succulents are converted into graveyards of charred embers." These brush fires have been intentionally set by Malagasy to improve grazing land for their cattle or clear land. Another threat to Pachypodia is collectors who tear specimens, especially bizarre forms, from mountain slopes (Preston-Mafham 1991). Few species are protected in reserves. Without strong conservation programs, these fascinating plants could easily disappear.

Other strange trees of the southern spiny desert include the Octopus Tree (*Didierea madagascariensis*), a member of an endemic family of 11 cactus-like species, Didiereaceae. This tree has no trunk, but a bouquet-like grouping of stems covered in long, needle-sharp spines that branch out in odd, twisted shapes. Although resembling cacti, this family has no close relatives anywhere in the world (Preston-Mafham 1991). Another member of the family, *Alluaudia procera*, has a thick trunk with very long spines that grow in curving rows upward, and small, rounded leaves along its branches. In spite of this, several lemur species are able to leap onto these plants without hurting themselves (Preston-Mafham 1991). Three species in this family, all of the *Alluaudia* genus, are Rare, according to the IUCN (Walter and Gillett 1998). One of these, *Alluaudia montagnacii*, has tall, solitary tapering stems ending in a tuft of flowers.

The discovery of the medicinal effects of the endemic Rosy Periwinkle (*Catharanthus roseus*) has saved thousands of human lives. Two potent alkaloid compounds found in this plant have proven effective in the treatment of Hodgkin™s' Disease, producing a 99 percent remission in patients with acute lymphocytic leukemia (Myers 1983). It also contains 75 different alkaloids, which could produce commercial substances (Preston-Mafham 1991). Fortunately, the Rosy Periwinkle is easy to propagate, grown in greenhouses around the world. Ongoing research is uncovering other Madagascan plants of medicinal value. Samples of plants are being tested in laboratories, and elderly Malagasy healers are being consulted. More than 50 species of wild coffee (*Coffea* spp.) grow in the island's eastern rainforests, providing an important genetic base for hybridizing with other strains because of their insect-resistance and low level of caffeine (Preston-Mafham 1991). These plants are symbolic of the great botanical wealth at risk.

The Biological Wealth of an Impoverished Country: Mammals

Home to some of the world's most fascinating, beautiful and curious mammals, Madagascar has approximately 117 native species, 90 percent of which exist nowhere else (Garbutt 1999). Excluding bats, all 88 native terrestrial mammals are endemic to Madagascar. Three-fourths of native mammals, or 66 species, are threatened with extinction; 49 of these are in higher categories of threat listed in the *2000 IUCN Red List of Threatened Species*. This represents 42 percent of all mammals found in Madagascar, by far the greatest percentage of threatened mammals of any country in the world (Hilton-Taylor 2000). As new species of mammals continue to be discovered, the numbers that are threatened continues to rise. A few have not been seen in the wild since their discovery. The majority is made of forest-dwellers, and a few inhabit marshy areas or woodland streams. The loss of forest, predation on them by Malagasy and domestic dogs, and introduction of exotic species of mammals that out-compete native species are combining to push many of the island's mammals toward extinction.

Page 1 (Tenrecs)
Page 2 (Lemurs and Aye-ayes)
Page 3 (Bats)

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The publication of *Mammals of Madagascar*, by Nick Garbutt, in 1999 filled a void for a complete guide to all native mammals, illustrated with color photos of most species and major habitats. This supplemented *Madascar: A Natural History* in 1991, an important reference on mammals and their environment. Conservation work has focused mainly on lemurs, with many organizations involved, including Earthwatch Institute, which sponsors field research; Conservation International; Jersey Wildlife Preservation Trust (based in England); and CARE. Several of these groups sponsored biodiversity studies and helped establish national parks, benefiting thousands of species, including tenrecs and other native mammals. A growing number of Malagasy zoologists are taking part in studies and conservation work, and new programs have been initiated to help local people while conserving mammals and their environments. Certain mammals have received inadequate attention to date, notably bats, rodents and some viverrids, who will undoubtedly benefit from the swell of interest and enthusiasm for Madagascar fauna that has developed in recent years. Filmmakers have recently produced a number of excellent wildlife documentaries, photographing rare species and spreading knowledge and concern about endangered mammals (see Video section).

Among Madagascar's mammals are many primitive forms. The tenrecs' closest relatives are insectivores known as solenodons, native to Cuba, Hispaniola and other vestiges of Gondwana in the Caribbean. Tenrecs and solenodons may have had a common ancestor living on the supercontinent, progenitor of all mammals. The remains of similar species have been found in Africa and South America, indicating that they were once very widespread but died out on all but isolated refuges such as Madagascar and West Indian islands. Tenrecs belong to a family of insectivores, Tenrecidae, related to shrews, moles and hedgehogs, but quite distinct from them. Twenty-seven species of three types of tenrecs make up this family--spiny, furred and otter-shrews (Garbutt 1999). They range in size from the Common Tenrec (*Tenrec ecaudatus*), which resembles the European Hedgehog and weighs more than 5 pounds, to the shrew-like tenrecs, *Microgale* genus, weighing less than 2 ounces (Nowak 1999). Tenrecs have some very unusual physical characteristics placing them far from any close mammalian relative. They have variable body temperatures that change with the ambient temperature and, an even more reptilian or avian trait, a cloaca that combines urinal, rectal and generative canals into one (Garbutt 1999).

A striking tenrec is the Lowland Streaked Tenrec (*Hemicentetes semispinosus*). It and a similar species, the Highland Streaked Tenrec (*Hemicentetes nigriceps*), weigh about 5 to 7 ounces and measure some 6 inches in length. White stripes run down their backs like skunks, and barbed, porcupine-like spines are detachable (Eisenberg 1975). The Highland species has a stiff, white neck ruff rising several inches at the back of its head that can be stabbed into the nose of an unwary predator (Eisenberg 1975). Family groups forage together and communicate by vibrating quills that produce low-frequency sounds like dry grass being rubbed together; tenrecs can detect these sounds from distances of more than 4 meters (Garbutt 1999). They also make a number of sounds that are audible to humans.

The Aquatic Tenrec (*Limnogale mergulus*), listed as Endangered in the *2000 IUCN Red List of Threatened Species*, inhabits streams and lakes, living at altitudes between 600 and 2,000 meters (Nowak 1999). This 8-inch tenrec has clawed, webbed feet, and a long, thin tail for propelling it through the water to feed on small crustaceans and fish. Its habitat in the central highlands has been greatly affected by human disturbance and deforestation. The Aquatic Tenrec has at least one refuge, the new Ranomafana National Park, created for the bamboo lemurs (Preston-Mafham 1991). In 1990, Dr. David Stone managed to lure an Aquatic Tenrec into a live trap, the first one of its kind seen alive in 25 years (Preston-Mafham 1991). Later, four more were taken and studied in captivity for three weeks prior to being returned to the river Namorona in Ranomafana, one of the few clear, unsilted rivers left in Madagascar (Preston-Mafham 1991). This species requires such streams, and only the preservation of forests, such as that in

Ranomafana, will ensure its survival.

Another six species in this family, all shrew-tenrecs of the genus *Microgale*, are listed in the *2000 IUCN Red List of Threatened Species*. These tiny insectivores are found in all parts of Madagascar in areas of heavy vegetation, and have dark, soft fur. They range in size from 1.5 to 5 inches in length, and weigh as little as 1.8 ounces (Nowak 1999). Several of the threatened species are highly restricted in range and habitat, and one, *Microgale dryas*, listed as Critical, occurs only in Ambatovaky Special Reserve in the northeastern rainforest (Garbutt 1999).

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Far better known to the world, the lemurs are the focus of many programs to conserve them, as well as research on their wild behavior and biology. New species continue to be discovered; most recently in 2000, three new species of tiny mouse lemurs. Three more have been rediscovered, an indication that other species may yet be discovered to add to the present total of 33 species (Garbutt 1999)**.** This is the only country with five families of primates, making up more than one-third of all primate families; it is home to 12 percent of all primate species and 21 percent of all primate genera (Mittermeier *et al.* 1999). Unlike Brazil, however, which is another center for endemic mammals, Madagascar is far smaller, the size of Kenya, covering 226,656 square miles, or 0.4 percent of Earth's surface (NYT 2000). The number of lemur species is not an indication of their variety since many subspecies differ so radically from one another that in the future, each may be accorded full species status. One species of sifaka, a long-legged kind of lemur, has one subspecies that is pitch black, and another that is pure white. At least 51 species and subspecies of lemurs are known to exist (Mittermeier *et al.* 1999).

The most gregarious of the lemurs are the Ring•tailed Lemurs (*Lemur catta*), who travel about in boisterous, friendly troops, living mainly on the ground. These lemurs have long, fox-like muzzles, large, soft golden-brown eyes, fluffy, gray fur, and black-and-white striped tails. Their body length is 15 to 17 inches, but their rope-like tails are half-again as long, from 21 to 24 inches (Nowak 1999). These 5-pound primates use their boldly patterned tails in a complex language of mutual visual and scent signals. They wave them about to show dominance, as a signal to follow other group members, or rub them on their wrist glands to wave at their rivals in territorial battles (Sleeper 1997). Moving about in troops of up to 25 individuals, they walk rapidly on the ground with the tail held high, waving it about. They wrap their tails around themselves for warmth on chilly nights. Extremely affectionate and playful, their core group is dominated by females (Jolly 1988).

In reserves where they are strictly protected, Ring-tailed Lemurs become very tame, napping on the ground in piles of leaves near tourists. Sometimes they sprawl out on their backs with arms spread wide apart. Females usually have a single young, but when twins are born, one may be "adopted" by a non-pregnant female, who may begin to produce milk in response to her surrogate role (Preston-Mafham 1991). Aunts also help in raising the young, and the daughter born the previous year babysits (Jolly 1988). Lemur babies are a source of great interest to the entire troop, females gathering around the mother and her young, grooming one another and the babies, forming a "grooming pod" (Preston-Mafham 1991). Only half of the infants survive their first year, and only 30 percent reach adulthood (Garbutt 1999). "A Lemur's Tale," shown on PBS in 1996, is a touching film about the death of a young Ring-tailed Lemur. Some fall from high branches, are killed by small carnivores or hawks, die of undiagnosed illness or starve in years of drought in their arid habitat. Ring-tailed Lemurs communicate with one another in a variety of sounds, from soft mewing contact calls to a territorial "bark-howl." Sometimes chasing and cuffing other members of their group, they are mainly peaceful, spending many hours a day in mutual grooming and in "snoozing-huddles," in which several animals form a complicated embrace from which tails and feet stick out in all directions (Preston-Mafham 1991).

In recent years, Ring•tailed Lemurs have been classified "high priority" for conservation by the IUCN and the Species Survival Commission (SSC) Primate Specialist Group because their habitat of dry woodlands in southern Madagascar

is disappearing at an alarming rate due to fires, overgrazing by livestock and tree cutting; they are also hunted with dogs in some areas, and captured as pets (Mittermeier *et al.* 1992, Garbutt 1999). Their distribution has become increasingly patchy as forests are cut (Garbutt 1999). The *2000 IUCN Red List of Threatened Species* lists the Ring-tailed Lemur as Vulnerable, or declining toward endangered status.

One of the strangest mammals in the world is the Aye•aye (*Daubentonia madagascariensis*), so unique that it is assigned to its own family, Daubentoniidae. When first discovered, scientists classified it as a squirrel because of its long, bushy tail and short•legged body. In 1863, however, after anatomical studies, the Aye•aye was revealed to be a lemur, in spite of incisor teeth that never stop growing, long, clawed fingers and other unlemur•like characteristics. Aye-ayes have a perpetually startled expression: huge, round protruding eyes dominate the face, the pupils completely surrounded by deep golden irises. Dark rings surround their eyes, heightening the eerie appearance. The rest of the face and body are gray to black, with long grizzled guard hairs. Spending the day in their twig and leaf nests, Aye-ayes emerge at night to forage for insects and fruit (Garbutt 1999). The Aye-aye's enormous ears are sensitive to the movements of insects under tree bark. At Duke University Primate Center, which has the world's largest number of captive lemurs, Aye•ayes have been filmed using their middle finger, which is twice the length of the other fingers, and skeletally thin, to tap on wood, listening for the movement of insects under the bark. When presented with a block of wood containing insect larvae in holes, the Aye•aye taps the wood and, cocking its head, can tell, even in the case of a hidden hole, the location of the insects, which it then extracts almost surgically, with its middle finger. This primate fills the ecological role of a woodpecker. Aye•ayes eat fruit as well, biting holes into the hard shells of coconuts and scraping the meat out with their middle fingers (Petter 1965). They have also been seen eating nuts of a native tree, nectar from the Traveller's Tree, fungus and lychee nuts (Garbutt 1999).

Aye-ayes have been heavily persecuted by the Malagasy, who consider them to be the embodiment of evil. In general, they are killed whenever seen. Dr. Ian Tattersall once found a dead Aye•aye with a wire pulled tight around its neck (McNulty 1975). In 1990, apparently to dispel the bad luck caused by its having entered a village, local people set an Aye•aye tail on a pole next to the road (Simons 1993). At one time, Aye-ayes were considered among the most endangered animals in the world, facing imminent extinction. To prevent their extinction, a few were captured and released on Nosy Mangabe, a small islet off the northeast coast. Fortunately, Aye•ayes survived on the main island, perhaps because coconut plantations provided food when their forests were cut. Feeding at night, they remained undetected until recently. The Malagasy continue to persecute them.

Since the early 1980s, field surveys have revealed that Aye-ayes have a larger distribution than was originally thought. In 1991, they were seen for the first time in western Madagascar in the northern mountains (Simons 1993). With confirmed sightings in many eastern and northern forests and a few western localities, Aye-ayes inhabit a variety of forest types (Garbutt 1999). They can survive in secondary forest, coming out of their stick nests only at night. And while once thought solitary, groups of three to four individuals have been seen traveling together and feeding at foraging sites (Garbutt 1999). In spite of the greater distribution, the Aye-aye is an endangered species and almost certainly is declining (Garbutt 1999). Aye-ayes require large tracts of forest to maintain viable populations and to protect them from the persecution that often results in their deaths (Garbutt 1999). Although very rare in captivity, several captive births have occurred in recent years at the Duke University Primate Center and Jersey Wildlife Preservation Society zoo in England.

One lemur has recently been rediscovered in the wild and, in the process, an entirely new species was found. The Greater Bamboo Lemur (*Hapalemur simus*) seemed to have disappeared in the wild some time in the mid-19th century. Not until 1964 was this 5-pound, grizzled, gray-olive lemur seen again in a village market, where it was purchased by a French scientist. Unfortunately, it escaped. A pair captured in 1972 in a southeastern rainforest lived in the zoo in Madagascar's capital city, Antananarivo, until both male and female and their two offspring died (Quammen 1996).

Patricia Wright, an American primatologist, decided to search for this species in 1986 in its supposed range. Fossil evidence indicates that 1,000 years ago, the Greater Bamboo Lemur was widely distributed throughout most of

Madagascar's forests, and European naturalists saw it fairly regularly in the 19th century. When she saw a russet-colored lemur clinging to a trunk, making loud "tonking" calls, Wright assumed that she had rediscovered the Greater Bamboo Lemur. Although a different color, she concluded that these animals probably represented a color variation (Quammen 1996). A German primatologist, Bernhard Meier, made independent studies in this patch of rainforest at the same time, also discovering the reddish-gold lemur. Both scientists had great difficulty making observations because of its extreme shyness (Quammen 1996). Finally one was caught, and in 1987, after chromosomal and anatomical studies were done in France, this lemur was found to be an entirely new species (Jolly 1988). It was named the Golden Bamboo Lemur (*Hapalemur aureus*) in a joint zoological paper by Meier, Wright and three other biologists (Preston-Mafham 1991). After months of unsuccessful attempts, Wright took the first photographs of the Golden Bamboo Lemur in the wild. Its beautiful golden-red face mask and belly contrast with darker brown fur on the rest of its body. (See color photographs in Garbutt 1999, Jolly 1988 and Preston-Mafham 1991). This lemur has been found at another location further north, and it is not known whether these populations are isolated from one another. Its population is apparently very low, as only about 1,000 animals have been estimated in the original location of discovery, and its habitat continues to be cleared (Garbutt 1999). The *2000 IUCN Red List of Threatened Species* has classified the Golden Bamboo Lemur as Critical, the most endangered category. Its limited range places it in great jeopardy, and it has been hunted with slingshots; its long-term survival is not secure (Garbutt 1999).

The Greater Bamboo Lemur, the animal first sought, was later found in the same forest, resembling original descriptions and clearly a separate species from the Golden Bamboo Lemur; a third species of bamboo lemur, the Gray Bamboo Lemur (*Hapalemur griseus*), weighs only 2 pounds. It has smoky gray fur and golden eyes, and lives alongside the latter two species in this same forest. This lemur lives in other parts of Madagascar as well (Preston-Mafham 1991).

Each of these three bamboo lemurs eats different parts or species of bamboo plants. One eats the leaves, another the pith, and the third confines itself to new shoots, leaf bases and pith from narrow stems (Quammen 1996). Amazingly, chemical analyses of the plants eaten by the Golden Bamboo Lemur found them to have high concentrations of cyanide, a chemical usually toxic to mammals. Golden Bamboo Lemurs weigh only about 2.2 pounds, and Wright and her co-workers found that, based on toxicity tests of other mammals, they eat 12 times the amount of cyanide that should kill them (Quammen 1996). This is another example of the biological mysteries of Madagascan wildlife.

The Ranomafana forest, with its rare and endemic lemurs and other unusual fauna and flora, would likely have been cut by the Malagasy for more farmland, but Wright spent five years in a successful effort to protect it in the newly•created Ranomafana National Park (Bohlen 1993, Mittermeier *et al.* 1992). This new park covers 108,000 acres of old-growth eastern lowland rainforest. Giant rosewood and other ancient trees tower above a lush understory. It is an extremely important--perhaps the most important--forest for lemurs. Fourteen species of lemurs and 18 other endemic species of mammals live in the park (Jolly 1988). Local people cooperated fully in setting the park™s boundaries, aware of the importance of saving forests. They had experienced a major catastrophe when a cyclone caused landslides, burying entire families in their homes, all precipitated by deforestation (Jolly 1988). In spite of these remarkable achievements, some tree cutting still occurs in Ranomafana National Park (Garbutt 1999).

Wright has continued to study lemurs, now specializing in the exquisite Diademed Sifaka (*Propithecus diadema*) (Brody 1998). Sifakas are the most acrobatic lemurs, leaping from tree to tree, but they have a unique means of locomotion to cross open spaces between trees. Standing on their long hind legs in an upright posture, they hop sideways, with their arms raised high above their heads. Sifakas can move very quickly in this amazing, dance-like gait, covering distances of more than 100 yards. They are also able to leap vertically to tree branches from a standing position, even carrying babies on their backs. One of their spectacular leaps, some 30 feet up, is the equivalent of a person jumping to the top of a telephone pole. The Golden-crowned or Tattersall's Sifaka (*Propithecus tattersalli*) is a beautiful, nearly all•white species with rich yellow-orange on the crown and tinges of this color on its back, legs and chest. Orange eyes contrast with a furless black face. The smallest of the sifakas, it is confined to a tiny area of only about 15 square miles of forest fragments in northeast Madagascar. The Golden-crowned Sifaka's small population of

fewer than 8,000 animals, fragmented into isolated populations, is threatened by forest cutting, brush fires, loss of habitat to agriculture and hunting (Garbutt 1999). Distributed in discontinuous patches of forest, these sifakas may become inbred if corridors are not acquired to link populations. A core part of their forest had been scheduled for cutting for charcoal when scientists named these sifakas. The PBS Nature program, fiMadagascar. Island of Ghosts,fl was the first to film these delicate lemurs (see Video section, Regional - Africa and Indian Ocean Islands). They move about in small groups and feed on a variety of unripe fruits, seeds, shoots, leaves, bark and flowers (Garbutt 1999). No reserve has been set aside for this highly endangered sifaka, although a three-parcel national park covering 20,000 hectares (49,420 acres) has been proposed to protect this species from extinction (Garbutt 1999). The IUCN classifies this species as Critical (Hilton-Taylor 2000).

Although many Malagasy have become far more aware of the need to protect lemurs, some do not understand their rarity or the importance of conserving them. Many rural people still hunt them for food or kill them because of superstitious beliefs. In some areas, the Malagasy try to sell lemurs to foreign scientists. Visiting zoologists studying lemurs have been approached by Malagasy holding captive, and usually injured or dying lemurs, in hopes of a reward. On one occasion, an endangered species of sifaka was brought to primatologist Dr. Alison Jolly, dragged half•choked by a vine around its neck, with one arm dangling loose below the elbow, a jagged bone protruding; blood oozed down its white fur, and it gasped for air through a muzzle smashed by a flung stone (Jolly 1980). Jolly expressed horror at its condition and refused to pay them any reward. She then amazed them by telling them it was a unique sifaka, found only in that small part of Madagascar. They were incredulous . . . not in Antananarivo? . . . Not in France? . . . Not in America? (Jolly 1980). For the majority of people, lemurs are familiar animals, easy to capture and valuable as food. Malagasy schools, established by the French colonial government, taught them only about European animals, encouraging people to assume that their lemurs were unimportant. Fortunately, many Malagasy are becoming concerned about protecting lemurs, and conservation education is taught in an increasing number of schools.

Some lemurs have bred in captivity in zoos and breeding centers, but most, like the endangered Indri (*Indri indri*), have never survived in captivity long enough to breed. In their rainforests, they perch high up, clinging to tree trunks to feed, and suddenly leaping vertically to a neighboring tree, pushing off with their extremely muscular, long legs. Panda-like fur of contrasting black and white--black faces and bodies and white arms and legs--gives them a dramatic appearance. Nearly tailless and heavy--but graceful--their eerie songs, sung at dawn and sometimes during the day, form a loud chorus of high-pitched voices that carries for long distances. Indris were once very common in the eastern rainforest, but much of their habitat has been burned away, making them extremely sensitive to the danger of fires. When a 1992 fire threatened a group in a reserve, they raised such a loud cry that the guards were alerted. They rushed to the scene and put out the fire (Rajaonson 1993).

Although originally found in the far north and central highlands, the Indri is now limited to a narrow strip encompassing only half the rainforests on the island (Garbutt 1999). Indris do not reach sexual maturity until between 7 and 9 years of age, and females are thought to give birth only every second or third year (Garbutt 1999). With such a low reproductive rate, they have been very vulnerable to habitat loss and hunting, especially by immigrants (Garbutt 1999). Moving about in small family groups, they are conspicuous to hunters. The Indri is one of the few lemurs whose killing is considered taboo by the Malagasy, but the old taboos are breaking down, resulting in capture and killing. In some cases, religious leaders encourage such killing. A lemur scientist met a Catholic priest who killed several Indris, roasted them and served them to his congregation, as recorded by Faith McNulty in 1975, and this killing has not ceased. In *Mammals of Madagascar* (Garbutt 1999), two terrified Indris were photographed clinging to poles in a hut, awaiting slaughter for food.

In contrast to the Indri, mouse lemurs (*Microcebus* spp) are so small that it is hard to think of them as primates. The tiniest is the newly discovered Pygmy Mouse Lemur (*Microcebus myoxinus*), with an average weight of only 30 grams, or 1.05 ounces, smaller than any other primate (Garbutt 1999). This tiny mammal is 2.73 inches long, with a tail just under 6 inches in length (Garbutt 1999). The other species are slightly larger, with body lengths ranging up to about 5 inches, and tails of equal or greater length (Garbutt 1999). These nocturnal lemurs have huge dark eyes and are agile and active, resembling African bushbabies. They feed on insects, spiders, and even small frogs and lizards, as

well as fruit, flowers and nectar (Nowak 1999). Females form groups and sleep in a nest together with up to nine individuals, while males usually nest alone or in pairs; occasionally males are found in a group of females (Nowak 1999).

A key to protecting lemurs and their forest homes is educating the people of Madagascar about them. The Jersey Wildlife Preservation Trust has put up posters with pictures of lemurs and their protected status around the island. Habitat protection is obviously key to conserving lemurs, and another recent development is the protection of the largest remaining area of rainforest in Madagascar. The Masoala Peninsula in the northeast is the sole home of the Red Ruffed Lemur (*Varecia variegata rubra*), a 9-pound, reddish subspecies of the Ruffed Lemur, but bearing little resemblance to the latter black-and-white species. With $3 million from USAID (United States Agency for International Development) and three years of planning, the new Masoala National Park, covering 210,000 hectares (518,910 acres or 840 square miles), was announced in June 1996 (Terry 1996). This immense park was formally signed into law on October 18, 1997 (Kremen 1998). Thai and Indonesian timber companies had hoped to log these virgin rainforests, but this new law will prevent clearcutting and slash-and-burn agriculture that would have destroyed the forest within less than 50 years. A coalition of organizations helped establish this park, including the Wildlife Conservation Society, CARE and the Peregrine Fund (Garbutt 1999). It will prevent the extinction of the endangered Red Ruffed Lemur, as well as that of the newly rediscovered Madagascar Serpent Eagle (*Eutriorchis astur*) (see below).

In 1997, five Ruffed Lemurs born and raised in the Duke University Primate Center in North Carolina were released in the Betampona Reserve in the northeast to bolster a small, isolated population of this species (Welch 1997). This reintroduction represented a goal in the captive-breeding program at Duke University, which has long planned such a return of these highly endangered primates to the wild. John Cleese, actor and a member of the 1970s British comedy team, Monty Python's Flying Circus, took an interest in the reintroduction program as an enthusiastic lemur admirer. After contributing to the Ruffed Lemur reintroduction program, he wanted to see how they were faring in the wild, and trekked to their remote release site. A delightful film based on this experience, "Lemurs with John Cleese," was shown on PBS in 1999. These Ruffed Lemurs have been released in an area of dense rainforest and rugged hillsides, a long hike from the nearest road. The biologists and assistants who take part in this reintroduction program show their dedication by living for long periods under extremely primitive conditions. Cleese managed to inject humor into this otherwise arduous situation.

At least six species of lemurs, and perhaps more, serve the ecologically important role of pollinating flowers. Many of Madagascar's plants produce unusually large flowers with strong odors and copious nectars attracting lemurs to feed on them. Should any of these lemurs become extinct, the plants that they pollinate will likely follow. Lemurs also play an important role in dispersing seeds. Research by the German Primate Centre at Hamburg University has found that Brown Lemurs are crucial to the regeneration of the western dry forests. About 10 percent of the island's tree species rely largely or entirely on this species to disperse seeds, which pass through their digestive systems.

The surviving lemurs are in extreme danger of following their relatives into extinction. Conservation organizations accord them extremely high priority among endangered primates, and they are the focus of many programs to preserve them. Twenty-nine of the 33 species are listed in the *2000 IUCN Red List of Threatened Species*, all but seven in higher categories of threat. This is an increase of nine species in the four years since the previous edition of the *IUCN Red List* was published (Baillie and Groombridge 1996). Three species and several more subspecies are in the Critical category of species on the verge of extinction, while seven are Endangered, an increase of four species since 1996. All lemurs are listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the category prohibiting commercial trade, and as Endangered on the U.S. Endangered Species Act.

Although lemurs are protected by Madagascan law, hunting is a major cause of mortality. High fines and even jail sentences may be imposed for killing a lemur, but the severity of the penalties might make officials reluctant to enforce the laws (Peterson 1989). Blowguns, snares, traps, sharpened sticks, slings, stones, guns or even clubs are used to kill them (Peterson 1989). To kill small species of nocturnal lemurs, trees are sometimes cut down, and

hunters seize them from their nest holes (Peterson 1989). In the late 1980s, a "sport" hunter bragged of killing 12 highly endangered Verreaux's Sifakas in one afternoon (Peterson 1989). In spite of education programs launched in the 1990s urging the Malagasy to protect lemurs, and the rise in tourists who come to see them, which provides revenues, few have benefited from tourism. Hunting remains a major threat (Garbutt 1999). The rise in human population has resulted in an increased demand for food, particularly protein, far more than the ailing agricultural system can supply (Garbutt 1999). The larger lemur species are especially affected. Because laws against killing lemurs are not enforced, much more education is needed about their potential value in attracting tourism and research funds that provide new jobs. Already tourism has raised income levels among some Malagasy, but hunger is still widespread (Tyson 2000).

In the late 1980s, a World Bank official studying the extreme and worsening poverty on the island said that there might come a time when the people of the capital city would scale the walls of the city zoo and eat the lemurs: "On the downward spiral, animals are at the bottom" (Peterson 1989). Such a tragedy is not inconceivable considering that hunger and poverty have deepened in the decade since. Conservation programs must involve communities while providing an incentive to conserve lemurs. Otherwise, it may be impossible to persuade the Malagasy not to slaughter them.

Although the status of lemurs is deteriorating along with their forests, much is being done to prevent their extinction. The past two decades have been of critical importance to lemur conservation. These extraordinary animals are receiving worldwide attention, and habitat protection for some species has been achieved. Not too long ago, their extinctions seemed inevitable and imminent. Conservation education programs, including showing slides of lemurs and other wildlife to rural children, have been launched. Wright helped to finance the building of new schools and the renovation of existing schools near Ranomafana National Park (Tyson 2000). A number of international organizations are integrating lemur and biodiversity studies with the economic development of entire communities (Garbutt 1999).

For a growing number of Malagasy, learning how special their lemurs are has made lemurs a source of pride and an important national treasure. In the future, Malagasy children may learn from an early age about lemurs and want to protect them. A few decades ago, few films had been made of these fascinating primates, while today many films show their habitats, biology and conservation work on their behalf. One is fiSpirits of the Forest,fl a charming film about many species of lemurs. Others are listed in the Video Section • Mammals. Films of lemurs and the island's environment would provide new insights about these animals if shown to the Malagasy people. Lemurs have also been prominently featured in *Madagascar: A Natural History*, by Ken Preston-Mafham, a beautiful and informative book, and the first guide book, *Mammals of Madagascar*, which provides color photos of nearly every species and subspecies, as well as information on habitats, conservation and status (Garbutt 1999).

In some areas of Madagascar, notably on Nosy Be island, lemurs are fully protected by taboo respected by the Malagasy. Here, beautiful Black Lemurs are fed by the villagers and tourists. This island is being developed intensively for tourism, and the strict nature reserve may be made into a national park (Tyson 2000). This will have mixed results, with new income flowing to the local people from park fees--one of the few countries where this occurs--yet with habitat lost and wildlife disturbed as a result of new hotels and a crush of visitors (Tyson 2000).

The gentle, curious gazes and charming behavior of lemurs have left an indelible impression on many people, and their extinction would be tragic, not just for biological reasons, but also because of their unique and delightful qualities.

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Bats, which perform vital ecological roles in controlling insect populations and pollinating plants, tend to be ignored

and often persecuted. Madagascar is no exception. Fifteen species of the 29 species of bats are endemic, living nowhere else (Garbutt 1999). The remaining 14 species live in mainland Africa as well. Fourteen species, or almost half the native bats, are listed by the *2000 IUCN Red List of Threatened Species*. The Yellow Bat (*Scotophilus borbonicus*), the most endangered, is listed as Critical (Hilton-Taylor 2000). This bat has been seen in both eastern and western regions but is extremely rare. A Vulnerable species, the Sucker-footed Bat (*Myzopoda aurita*), is the sole member of its family, Myzopodidae, and an extremely unusual bat. It is able to walk up tree leaves using sucker disks at the bend of its wings and on its feet to adhere to the slippery leaves (Jolly 1988). Only 2 inches long, with a forearm length of 1.9 inches, this tiny bat occurred in East Africa during the Pleistocene, but at present, it is found only in several locations in the eastern rainforest region of Madagascar (Garbutt 1999). It roosts in the Traveller™s Tree. It possesses a complex echolocation system and emits very long calls used to hunt insects (Garbutt 1999).

The largest bat, the endemic Madagascar Flying Fox (*Pteropus rufus*), has a 4-foot wing-span. An extremely colorful bat, its crown and nape are yellowish, and its upper chest and shoulders are rufous to golden brown (Garbutt 1999). It feeds on fruit juices by squeezing pieces of fruit pulp in its mouth, swallowing the juice and very soft fruit pulp, especially of figs, papayas, lychees and guavas (Garbutt 1999). Colonies of these bats roost in tall trees in primary forests or plantations (Garbutt 1999). One large roost at the Berenty reserve has decreased, apparently because of daytime disturbance by tourists who come to see them hanging upside down in the tamarind trees (Preston-Mafham 1991). Elsewhere on Madagascar, the species has declined precipitously from hunting for its meat; only on inaccessible offshore islands do these bats survive without persecution (Preston-Mafham 1991). Of Asian origin, this species is related to fruit bats in the Mascarene Islands. Through captive studies, flying foxes have been found to be extremely devoted to one another (see discussion of Rodrigues Flying Fox in Chapter One).

The Biological Wealth of an Impoverished Country: Mammals: Page 4

The Viverrid family is represented in Madagascar by mongooses, civets, and related carnivores that have evolved into eight species of three endemic subfamilies (Preston-Mafham 1991). Their ancestor is thought to have originated in Africa, and may have colonized the island at an early period. The largest carnivore on the island is the Fossa, or Fosa (*Cryptoprocta ferox*). A zoological oddity, it resembles the Jaguarundi, a neotropical cat, but most authorities place it either in the Viverrid family with civets (Preston-Mafham 1991) or the Herpestidae family with mongoose (Nowak 1999). The only member of its genus, it walks flat on its feet, rather than on its toes like cats (Nowak 1999). Sleek and slender, with golden reddish-brown fur, it has a small head with a blunt, dog-like muzzle, and an extremely long tail. Males weigh up to 22 pounds, with a body length of 2.6 feet and a tail of equal length, while the smaller females measure 2.3 feet and weigh about 15 pounds (Garbutt 1999). It has scent glands which discharge a strong odor when the animal is irritated (Nowak 1999). Widespread but rare in forests throughout the island, this nocturnal predator kills small lemurs, rodents and tenrecs, as well as birds, reptiles, amphibians, invertebrates and, reputedly, domestic chickens (Garbutt 1999). The Fossa often excavates animals from their burrows and can pursue fleeing prey by climbing up trees (Nowak 1999).

The first research study of the Fossa is being conducted by zoologist Luke Dollar, funded by the Earthwatch Institute. Helped by volunteers, he is radio-tracking several Fossa to determine their movements, habits and territory size. As the largest predator on the island, the Fossa plays an extremely important role in the evolution, behavior and population dynamics of lemurs and other prey animals. During the research project, several Fossa have shown extreme confidence by raiding the tents of the researchers when unoccupied, ransacking them and even chewing metal objects, leather boots, rucksacks, soap and bottles of malaria tablets (Garbutt 1999). For centuries, Fossas have been persecuted by the Malagasy, believing them to be ferocious and evil.

The Fossa gives birth to a litter of two to four young, which mature very slowly and may not be fully independent until they are about 4 years old (Garbutt 1999). This slow rate of reproduction has made the Fossa vulnerable to

extinction. Along with losses from killing by the Malagasy, its forest home has been steadily whittled away by slash-and-burn agriculture. The Fossa is listed as Endangered in the *2000 IUCN Red List of Threatened Species*, a higher category of threat than it received in the 1996 version of this list.

Gerald Durrell, renowned author and conservationist, traveled in the western forests to capture Aye-ayes for captive breeding. He encountered a Fossa venturing out during the day--an unusual behavior: "A flash of russet red caught my eye in the bushes some six feet in front of the vehicle and, suddenly, from out of the undergrowth, silent as a cloud shadow, came a Fossa which walked languidly to the middle of the road and sat down" (Durrell 1993). Remaining there, the Fossa proceeded to groom himself, apparently unaware of Durrell's presence. Then, with a sigh and a wide yawn, the Fossa crossed the road and disappeared into the forest, "his immense sickle of a tail swinging from side to side like a bellrope behind him. To have spent ten minutes with such a rare and beautiful creature was a privilege" (Durrell 1993).

The Falanouc (*Eupleres goudotii*), sole member of its genus and a viverrid, is the size of a domestic cat. It has dense, woolly fur and an extremely pointed and narrow muzzle. Native to humid eastern lowland forests and marsh areas and portions of the northwest, Falanoucs are active at twilight and during the night. Feeding mainly on earthworms and other invertebrates, they use their long snouts and tiny, conical teeth to catch prey in leaf litter (Garbutt 1999). The species is rare or extremely rare over most of its range and is classified as Endangered by the IUCN (Hilton-Taylor 2000). Like the Fossa, it has declined as a result of deforestation, drainage of marshes, hunting by the Malagasy, attacks by feral domestic dogs, and possibly competition with the introduced Small Indian Civet (*Viverricula indica*).

The Malagasy Civet or Fanaloka has the scientific name *Fossa fossana*, which has been confused with the Fossa. Like the Fossa and Falanouc, it is the only member of its genus. Looking more like spotted civets from mainland Africa and Asia, this reddish 3-pound carnivore has rows of black spots on its back, merging into stripes toward its bushy, grayish tail. Its distribution is far more restricted than the Fossa's or the Falanouc's, being confined to eastern rainforests which have been reduced to less than 10 percent of their original size. Sheltering in tree holes or crevices, the Malagasy Civet lives in pairs and feeds on crustaceans, worms, small eels and frogs (Nowak 1999). A pair has a single young, and a captive civet lived 11 years. Hunting and trapping have also threatened the Malagasy Civet, which is listed as Vulnerable by the IUCN (Hilton-Taylor 2000).

Five other viverrids, all mongooses, are native to Madagascar, and all are threatened with extinction from a loss of forest habitat and persecution. A few have very restricted distributions. They tend to be secretive unless in a secure forest reserve, and little attention has been paid to their conservation, biology or habitat requirements. Several are uniform brown or russet, while two have bold black dorsal stripes ending in white, bushy tails. One, the Brown-tailed Mongoose (*Salanoia concolor*), is native to the northeast rainforests, but almost nothing is known of this small carnivore (Garbutt 1999). All of the eight native civets, mongooses and related animals are listed as Vulnerable or Endangered by the *2000 IUCN Red List of Threatened Species*.

The Biological Wealth of an Impoverished Country: Mammals: Page 5

Among Madagascar's 11 species of murid rodents are several extremely bizarre forms. The largest is the Giant Jumping Rat (*Hypogeomys antimena*), the size of a rabbit and weighing 2 pounds, 10 ounces (Preston-Mafham 1991). Restricted to a small area in western dry, deciduous forests north of Morondava, in west-central Madagascar, its entire range is thought to encompass only 39 square miles (Preston-Mafham 1991). Once far more widely distributed, remains have been found in southwest and central Madagascar (Garbutt 1999). These huge rodents search for food, such as fallen fruit, on the forest floor and feed by sitting on their hindquarters and holding food in their forepaws like a rabbit (Garbutt 1999). Giant Jumping Rats build deep burrows and, unlike the vast majority of rodents, a mated pair maintains long bonds with one another and with their young (Garbutt 1999). Male young leave after one year, and

females stay with both parents for two to three years (Garbutt 1999). Only one or two young are born in a litter, and predation by Fossa and the Madagascar Ground Boa (*Acrantophis madagascariensis*) is high (Garbutt 1999). With no reserve and a habitat that continues to decline, this huge-eared rodent is in danger of extinction. A reserve is planned for this species, which is listed as Endangered by the *2000 IUCN Red List of Threatened Species*. fiMadagascar. Island of Ghostsfl filmed the Giant Jumping Rat in the wild, one of the only videos of this fast-disappearing species (see Video section).

Eight of Madagascar's native rodents, or 73 percent, are listed by the IUCN in various categories of threat. Two are considered Critical: the Madagascar Mouse (*Macrotarsomys ingens*) and the Madagascar Rat (*Eliurus penicillatus*). The mouse is known only from a single area in northwestern Madagascar, in dry deciduous forests where the type specimen was found, and it is thought to be almost totally arboreal and nocturnal (Garbutt 1999). The Madagascar Rat has not been seen since the type specimen was collected in central-eastern montane rainforest.

The Biological Wealth of an Impoverished Country: Birds

The Biological Wealth of an Impoverished Country: Birds: Page 1

Until recently, the amazing lemurs and other mammals of Madagascar eclipsed its remarkable bird life. Apart from the extinct elephant birds, 120 species of the 204 native birds are unique to the island (Morris and Hawkins 1998). Like tropical birds of other parts of the world, most are dazzlingly beautiful in brilliant hues. Unlike most tropical birds, however, they represent fascinating examples of evolution, including families of birds that exist nowhere else, having evolved from a single ancestor into many forms, some very bizarre. Most ornithologists recognize five bird families as unique to Madagascar, each with extremely distinctive characteristics. Four of these have some or all species that are threatened. The fifth, a family consisting of a single bird, the Cuckoo-Roller (*Leptosomus discolor*), is secure for the moment (Morris and Hawkins 1998). A few thousand years ago, there may have been far more native bird species that disappeared without a trace as their habitats were destroyed.

Native birds are not thriving, as people and livestock destroy their varied habitats, to which they had adapted over thousands of years. A total of 41 species, all but three of which are endemic, have been listed in the *2000 IUCN Red List of Threatened Species*, based on the research of BirdLife International published in 2000 in *Threatened Birds of the World*. The latter book illustrates each threatened Madagascan bird and describes status, population numbers, distribution and other pertinent information. The three non-endemic birds also breed in the neighboring Comoros or Seychelles (BI 2000). Thus, 20 percent of all native birds and 34 percent of endemic birds are threatened, five species listed as Critical, six as Endangered, 16 as Vulnerable, and 14 as Near-Threatened (BI 2000). Moreover, many native birds that were once widespread have become restricted to isolated forest reserves and parks, not yet endangered but far less numerous than in previous times. While the percentage of threatened birds is less than that of endemic mammals, it is significant, especially considering that 27 species are either Critical, Endangered or Vulnerable in the *2000 IUCN Red List of Threatened Species.* Madagascar has more threatened birds that all of the continental United States (excluding Puerto Rico and Hawaii). Its threatened birds total 41 threatened species, five greater than the United States™ 36 (BI 2000). Only 4 percent of the 810 breeding birds native to continental US and Canada combined (Sibley 2000) are threatened. If birds in the United States faced the same degree of threat as Madagascar's birds, at

least 162 species would be threatened with extinction.

Fortunately for the future of these unique birds, organizations such as BirdLife International; the Peregrine Fund; Conservation International; the Jersey Wildlife Preservation Trust; and an ad hoc group, The Working Group on Birds in the Madagascar Region, are researching and working to conserve Madagascar's native birds. Malagasy ornithologists and members of the public are participating in surveys, studies and conservation programs. An inventory of the status and taxonomy of all of Madagascar's birds is in progress (Morris and Hawkins 1998).

In spite of Madagascar™s many unusual birds, interesting to specialists and amateur birdwatchers alike, no bird guide or text illustrating and describing the island's avifauna existed until 1990, when Olivier Langrand's *Guide to the Birds of Madagascar* was published, providing information on natural history, status, habitats and distribution, as well as color paintings of all native birds. This material supplemented the lengthy descriptions in *Threatened Birds of Africa and Related Islands*, a 1985 publication of the International Council for Bird Preservation, now called BirdLife International (Collar and Stuart 1985). *Madagascar: A Natural History*, by Ken Preston-Mafham (1991), included extensive information on many native birds and their habitats. *Birds of Madagascar, A Photographic Guide* (Morris and Hawkins 1998), published in 1998, updates the latter publications with vivid color photographs illustrating almost all native birds, including many species discovered or rediscovered during the 1990s, such as the two new species, the Cryptic Warbler (*Cryptosylvicola randrianasoloi*) and the Red-shouldered Vanga (*Calicalicus rufocarpalis*), and the rediscovery of several birds thought extinct: the Madagascar Serpent Eagle, Madagascar Red Owl (*Tyto soumagnei*) and Red-tailed or Fanovana Newtonia (*Newtonia fanovanae*). The 1990s also saw the making of many films about the island's wildlife, including its birds (see Video section).

The Biological Wealth of an Impoverished Country: Birds: Page 2

Birds native to aquatic habitats have declined even more dramatically than many forest birds. The largest lake on Madagascar, Lake Alaotra in the northeast, was once a paradise of waterbirds, turtles, frogs and other wildlife. Traditionally, portions of the lake were used by the Malagasy for rice cultivation, without serious damage to the environment or resident wildlife. But as their populations and food requirements grew, people began to destroy more and more of the natural marsh and reed beds that lined the lake, and cleared the surrounding forest for firewood and agriculture. This destroyed the lake's water quality. With no trees to hold back the soil and conserve water, this once-beautiful lake became heavily silted by runoff (Durrell 1993). Added to this, non-native tilapia fish were introduced into the lake as a food source for the local people. The fish eat vegetation needed by dragonflies and other fauna that form the basis of the lake's food chain (Preston-Mafham 1991). This ecological collapse has greatly reduced rice production on the lake, although reeds are still being cleared for rice growing, fragmenting wildlife habitat (Garbutt 1999).

The effects on native aquatic birds have been catastrophic. Lake Alaotra is the only known habitat of the endemic Alaotra Grebe (*Tachybaptus rufolavatus*), which is presumed extinct (BI 2000, Morris and Hawkins 1998). No sightings have been made since 1985, when only two birds were seen. It declined from loss of its habitat, hunting and hybridizing with the Little Grebe (*Podiceps ruficollis*), a recent arrival from Africa (Morris and Hawkins 1998). Many fruitless searches for the species have been carried out in the lake and surrounding area since then (BI 2000, Morris and Hawkins 1998). This small, black-capped grebe was very sedentary and may have been nearly flightless because of its extremely short wings.

Another waterbird restricted to Lake Alaotra, the Madagascar Pochard (*Aythya innotata*), is also probably extinct, having been eliminated by the same threats as the Alaotra Grebe (BI 2000). This duck declined steeply from 1930 on, and the last known bird, a male, was captured in August 1991, having been caught in fishing gear. This bird later died, and intensive searches in 1989 and 1990, and again in 1993 and 1994, failed to discover more Madagascar Pochards

(BI 2000, Collar *et al.* 1994). A handsome bird, the pochard was chestnut-colored, with dark gray bill and yellow eyes (see photograph in Morris and Hawkins 1998). A shy species, its breeding and behavior were studied, but apparently nothing was done during its precipitous decline to prevent its extinction. Classified as Critical, hope remains that a few birds exist in wetland habitats around Lake Alaotra (Morris and Hawkins 1998).

The Jersey Wildlife Preservation Trust has begun education campaigns in the vicinity of Lake Alaotra to teach local people about the presence of the highly endangered Alaotra Reed Lemur or Bandru (*Hapalemur griseus alaotrensis*), a subspecies of the Grey Bamboo Lemur, and the importance of protecting the reed and papyrus beds. This lemur has been classified as Critical by the IUCN. The only lemur to live in an aquatic environment, the Alaotra Reed Lemur is larger than other subspecies of the Grey Gentle Lemur and lives in close, family groups (Garbutt 1999). To move about in the reed beds, they climb up a reed stem until it bends, and then walk along it to reach the next stem; their major food is the endemic papyrus, along with grasses and ferns (Garbutt 1999). Lake Alaotra's reed beds are its sole habitat, and although previously widespread in this and another lake to the north, only two isolated populations of lemurs, one of which numbers fewer than 60 animals and is on the verge of extinction, remain in marsh fragments (Garbutt 1999). This lemur has the most restricted range of any lemur species or subspecies (Garbutt 1999). The film, fiMadagascar. A World Apart,fl includes a moving segment on these lemurs feeding among the papyrus when a Malagasy canoe enters the marsh and sets a fire, causing the terrified lemurs to flee. (See Video section). Local village leaders have requested that the government set aside a protected zone in the marshes. There is hope that this lake will be brought back as a functioning ecosystem in the future and that a strict sanctuary will be set aside for this endangered lemur and the highly endangered waterbirds.

While sizeable areas of forest have been protected, few aquatic environments on Madagascar have been preserved, and native waterbird species are declining precipitously. The Madagascar Little Grebe (*Tachybaptus pelzelnii*) was once common and widespread in many parts of the island; with the pollution and destruction of marshes throughout the island for rice farms, this bird has declined greatly. The introduced tilapia was threatening this species by consuming its food supply. This grebe also hybridizes with the introduced Little Grebe (Collar *et al.* 1994). The Little Grebe, an African species which has colonized the island, prefers the habitat created by the tilapia, and is now abundant (Langrand 1990). The Madagascar Little Grebe has also drowned in fish nets, and has lost the vegetation it needed for nesting (BI 2000). It is expected to follow the Alaotra Grebe and Madagascar Pochard into extinction.

Another endemic waterbird, the Sakalava Rail (*Amaurornis olivieri*), native to western wetlands, is also extinct or nearly so. A small, sooty-black bird with yellow beak and pinkish-red legs and feet, it was native to streams and marshes in the western parts of the island. For more than 30 years, this species was not seen at all. In 1995, one was glimpsed at Lake Bemamba, and another in 1999 at the same lake (BI 2000). This species is classified as Critical (BI 2000), and Lake Bemamba and other lakes and wetlands on the west coast may be given protection by the Malagasy government, which has ratified the Ramsar Convention on wetlands preservation (BI 2000).

As a result of extensive habitat destruction and hunting, the Madagascar or Bernier's Teal (*Anas bernieri*) has likewise declined to endangered status in the few sites from which it is known on the west coast. Once widespread on the island, it is now restricted to a few marshes and shallow lakes. Small populations remain on Bemamba Lake and a few other sites (Morris and Hawkins 1998), and a flock of 67 was seen in another area (BI 2000). In 1970, 60 of these birds were seen on a lake, and as soon as this became known, European sportsmen went to the lake and killed more than 25 percent of the population (Curry-Lindahl 1972). In the 1970s, Bernier's Teal inhabited Lake Masama, but heavy hunting by both Europeans and natives with dogs has nearly eliminated them (Todd 1979). In 1993, four birds were captured for captive breeding (Collar *et al.* 1994). The Jersey Wildlife Preservation Trust is working to preserve this beleaguered species and the marshes of the west. The Madagascar Teal has been seen in three protected areas, and a conservation program at one lake has been initiated (BI 2000).

The critically endangered Madagascar Fish Eagle (*Haliaeetus vociferoides*) numbers about 250 pairs in the 600-kilometer stretch of western coastline to which it has become confined (BI 2000). This large eagle resembles the African Fish Eagle, from which it probably evolved, but instead of a snowy white head and upper body, it is streaked

with brown and has shaggy, buff crown feathers. About 35 inches long, with a 6.5-foot-wingspan, it is by far the largest bird on Madagascar. Persecuted by local people, these eagles have been shot and their nests destroyed. On one occasion in the 1990s, ornithologists saw some immigrants cut the tree where an active nest of a Madagascar Fish Eagle was located, and proceed to kill and eat the chicks! The only remaining habitat for this species is the western coast, where mangrove swamps are rapidly being destroyed (Langrand 1990, Preston-Mafham 1991). The Peregrine Fund is sponsoring research on this species, and 10 nests have been located in an area on the west coast in the Three Lakes Complex (BI 2000). The Fund has removed and raised chicks that would have been killed by siblings and released them to augment the population. The fish it feeds on are being depleted, however, by a gill-net fishery that has recently been established. A new Malagasy law allows local communities to control their own resources, and the people in this region are being encouraged to formalize conservation regulations prohibiting gill netting and tree cutting.

The Biological Wealth of an Impoverished Country: Birds: Page 3

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cutting.

The Biological Wealth of an Impoverished Country: Birds: Page 4
As more and more bird-watchers come to Madagascar, the government may place a higher priority on bird conservation. A special fund to which bird-watchers could contribute might be established to purchase and maintain refuges and to conduct conservation education and other projects for local people, especially in aquatic habitats. The preservation of threatened Madagascan birds has reached a critical point. The most endangered habitats, the last of the western forests, aquatic environments, and many parts of the eastern lowland rainforests, continue to decline. The fragmentation of forests that forces animals into islands of isolation needs to be studied and remedied by establishing habitat corridors between them. One Malagasy ornithologist, Aristide Andrianarimisa, is researching the effects of forest fragmentation on birds.

Pete Morris and Frank Hawkins, authors of *Birds of Madagascar. A Photographic Guide*, state that their purpose in writing their book was to inspire people to visit Madagascar and take an interest in its avifauna and the plight of so many threatened birds, as well as to promote greater interest in wildlife and conservation among the Malagasy people. Ecotourists bring revenue to the island and, thereby, help to preserve natural areas and wildlife (Morris and Hawkins 1998). The discovery of a new species of songbird, the Cryptic Warbler, by bird-watchers in Ranomafana National Park, is an exciting byproduct of ecotourism and an indication that the study of Madagascar's birds has just begun. It also proves that amateurs play an important role in bird observation. *Birds of Madagascar* establishes a good precedent by identifying, on a species-by-species basis, the avian habitats and those birds lacking reserves within their ranges. The authors request that people coming to see the wildlife of the island let the government know why they have come in order to convince decision makers that biodiversity conservation represents a worthy investment (Morris and Hawkins 1998).

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians
The distribution and diversity of Madagascar's reptiles and amphibians have not been carefully researched until the present. Chris Raxworthy, a British herpetologist, is in the process of carrying out the first methodical survey of the estimated 500 non-marine species, all of which are endemic (Holmes 1997). To date, at least 300 reptile and about 200 frog species have been identified (Tyson 2000). This would make it one of the top five countries in the world for diversity of reptiles and amphibians. The British Isles, by contrast, with about half the land area of Madagascar, have only six species of reptiles (Preston•Mafham 1991). Even the ranges of newly described lizards and frogs will not be delineated precisely for some time. Some areas remain unexplored by herpetologists, and Raxworthy finds new species of lizards and frogs on each expedition into the tangled swamps and forest fragments. On one day when accompanied by a journalist, he and fellow researchers, including Malagasy biologists, found a bright green day gecko, a strikingly beautiful yellow-and-black snake, tiny frogs resembling lichens, a leaf-tailed gecko and 4-inch chameleons with upper legs the colors of Rainbow Trout, and lower legs like toothpicks (Holmes 1997). In a reserve on Nosy Be island, he and some Earthwatch Institute volunteers rediscovered a 10-inch green lizard that had been lost to science since the 1890s, when last collected (Tyson 2000). Raxworthy is doing inventories in reserves as part of an island-wide biodiversity program, and hopes that in some impenetrable area, giant tortoises long considered extinct will be rediscovered (Holmes 1997).

Page 1 (Threatened)
Page 2 (Tortoises and Turtles)
Page 3 (Lizards)

Page 4 (Snakes)
Page 5 (Amphibians)

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Of these native reptiles and amphibians, at least 19 are known to be threatened with extinction. A preliminary list includes 17 species of reptiles (four tortoises, a freshwater turtle, four sea turtles, a gecko, four chameleons and three boa snakes) and two amphibians, both frogs. All are in higher categories of threat: Endangered or Vulnerable by the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000). All but the sea turtles are endemic to Madagascar.

The arid regions at the northern and southern ends of Madagascar are home to two intricately patterned tortoises, both in danger of extinction. In the north is a species considered by many to be the world's most endangered tortoise: the 18-inch Madagascar or Plowshare Tortoise (*Geochelone yniphora*), whose tan, domed shell is marked with narrow black lines in delicate hexagonal patterns. The Plowshare name came about because of a protuberance on the tortoise™s lower shell that turns up, a kind of knob that remotely resembles a plowshare. This knob is used by males in sparring contests. From the 17th century onward, thousands of these tortoises, which were once abundant and widespread, were shipped every year to the nearby Comoro Islands to use as meat for settlers, driving the species to the edge of extinction before the trade finally ended in the 19th century (Juvic *et al.* 1981). Their populations never recovered, due to the continued take by villagers for pets and the massive destruction of their habitat. Known to the Malagasy as the "Angonoka," this tortoise was headed for extinction until 1985 when the Jersey Wildlife Preservation Trust was requested by the IUCN to work with the Malagasy government in formulating a rescue plan, Project Angonoka (Reid 1995). Research on the tortoise™s wild status and behavior began immediately, and a captive-breeding program was established at a government forestry station (Reid 1995).

By 1986, eight adult tortoises had been gathered from the wild and placed in an enclosure which had ample vegetation and conditions natural enough that two male Angonokas immediately began their fights of strength (Reid 1995). Gerald Durrell, founder of the Jersey Wildlife Preservation Trust, in his book, *The Aye-aye and I* (1993), described lone males showing no interest in breeding, even if surrounded by females. But when another male is present, they face each other prepared for combat: "The two males, rotund as Tweedledum and Tweedledee dressed for battle, approach each other at what, for a tortoise, is a smart trot. The shells clash together, and then the plowshare comes into use. Each male struggles to get this projection beneath his opponent and overturn him to win a victory in this bloodless duel" (Durrell 1993). Finally, when one is able to overturn his opponent, he lumbers over to mate with the female while the vanquished male "wanders dispiritedly away" (Durrell 1993).

Project Angonoka has shown success both in captive breeding these tortoises, which may number only between 300 and 1,000 in the wild, and in working with local people to conserve remaining wild populations (Durbin *et al.* 1996). In fact, by 1995, a total of 140 captive-bred juveniles, ranging in age from 10 months to 6 years, had been produced at the breeding center. The breeding program was described in an illustrated article entitled "Observations on Hatchling and Juvenile Captive-bred Angonoka in Madagascar," published in the Jersey Wildlife Preservation Trust's annual journal, *The Dodo,* issued early in 1996. Within months, the captive-breeding program was devastated by the theft of 76 animals--two adult females and 74 hatchlings. On May 6, 1996, someone cut through the flimsy chain-link fence and the wire of the enclosure and took half the animals that were the fruit of a decade's work. Not until a female is 20 years old does she begin breeding, so the loss of two breeding females and their hatchlings dealt the program a devastating setback (McNeil 1996a). The burglary may have been an inside job, since the dog on the premises did not bark to alert the personnel who were sleeping close by (Tyson 2000). It is unlikely that these adult females will breed in captivity, as there are almost no adult male Plowshare Tortoises in breeding programs, and without more than one, no breeding occurs.

Animal smugglers care little about the effect of their actions on the survival of endangered species. Reptile collectors will pay thousands of dollars for rare specimens, and this break-in had been planned. A Dutch rare animal dealer had advertised Plowshare hatchlings for sale the month before, at $3,000 apiece, saying they would be "available soon" (McNeil 1996a). Ten of the hatchlings were traced to Prague, where wildlife law enforcement is weak, and others were suspected to be in the Netherlands, where they would be sold to collectors in the United States, Spain, Germany and Japan (McNeil 1996a). The loss of these tortoises cost the breeding program years of work. Don Reid, the Conservation Field Officer in charge of the Plowshare Tortoise captive-breeding program, had experimented for years to achieve a proper diet for the tortoises, arranged male combats, and conducted lengthy experiments to learn proper conditions for the eggs to hatch (Reid 1995). These tortoises became so tame that they would stretch their necks out to be scratched (McNeil 1996a). Although discouraged by the theft, he continued the breeding program; 40 new tortoise hatchlings were produced in late 1996, bringing the total to 130 juveniles. In 1998, several of the smuggled tortoises were seized from a Malaysian animal dealer in Mexico City who had been the subject of a long-term U.S. Fish and Wildlife Service undercover investigation. The same year, three more Plowshare Tortoises were seized in Belgium as they were being imported (TRAFFIC 1999a). The species is listed by the *2000 IUCN Red List of Threatened Species* as Vulnerable, and is protected by the Malagasy government, which bans trade.

Officials from the Jersey Wildlife Preservation Trust and other conservationists have sponsored education programs aimed at informing local people about the tortoises and their rarity. This has resulted in their cooperation in helping to guard wild tortoises from poachers and control brush fires (Durbin *et al.* 1996). This region in northwestern Madagascar has lost most of its forest cover; Arab residents cut trees and burn them to clear the land for agriculture, and feral pigs kill the young wild tortoises (Durbin *et al.* 1996). So much clearance of natural vegetation has taken place that the climate has become increasingly more arid, causing ponds to dry up. Tree cutters are now turning to the mangroves, causing siltation of the inlets, which affects prawn harvests (Durbin *et al.* 1996) and destroys a key aquatic environment on the island.

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians: Page 2

The Plowshare Tortoises have been reduced to a few forest sites, and in spite of the urgent need for a reserve, none has been set aside. The area is getting conservation help with the formation of a new organization by conservation biologists, the Association to Safeguard the Environment. Its purpose is to involve local people in environmental projects, such as planting cashew trees, learning fire suppression methods, and trapping bush pigs; they are also giving conservation lessons to children and conducting literacy classes (Durbin *et al.* 1996).

The Radiated Tortoise (*Geochelone radiata*) inhabits the drylands of the extreme south, where the strange Didierea plants and other desert vegetation grow in open shrubland. Many people consider this tortoise to be the most beautiful in the world. Delicate yellow sunburst patterns adorn the top of its 16-inch-long black shell, and the underside is marked with diamond patterns. These tortoises also declined after tens of thousands were killed to supply local villagers with meat, or exported to the Comoro Islands from the 17th century on for meat markets abroad. In 1922 alone, 22,000 of these tortoises were exported (Jolly 1980). The legal trade did not cease until 1930. The tortoise populations have not rebounded, and illegal capture for collectors and zoos may be the explanation. The slow reproduction of this species means that it cannot quickly make up for losses in its population. An extremely long-lived species, it has evolved with low natural mortality and has few young. As an example of its longevity, a Radiated Tortoise of unknown age presented to the Queen of Tonga by Captain Cook in the 1770s, lived until 1966, making it almost 190 years old at its death (Jackson 1993).

The lovely patterns on this tortoise's shell, which vary from individual to individual, have placed it in great demand around the world, encouraging poverty-stricken Malagasy to risk jail to earn the money that these tortoises bring.

Thousands of Radiated Tortoises have been collected for the international market, sold in Europe, North America and elsewhere for $2,000 or more per animal. In spite of having a range that is far larger than that of the Plowshare Tortoise, the Radiated Tortoise is declining rapidly toward extinction. The species is listed by the *2000 IUCN Red List of Threatened Species* as Vulnerable. Export and collection of Radiated Tortoises are prohibited by the Malagasy government, with severe penalties for violations including prison sentences. The United States lists both the Radiated and Plowshare Tortoises on the Endangered Species Act, which prohibits commercial importation. International commercial trade is banned by their listing on Appendix I of CITES. Still, the smuggling continues, fed by the many wealthy collectors who have no conscience about the effect their purchase has on wild populations, and the zoos that knowingly purchase smuggled animals. Malagasy authorities have failed to put an end to the poaching, especially of the Radiated Tortoise and other southern species.

Donovan Webster, a journalist, researched the rampant smuggling of Radiated Tortoises and other wildlife from the island for *The New York Times Magazine*, which published his lengthy article on February 16, 1997. The magazine cover featured the article and read: "I was caught in Madagascar. Peddled for 30 cents. Smuggled to Orlando. Sold for $10,000. I'm a rare, coveted tortoise--coldblooded contraband." Webster found that Madagascar was a "pirate's paradise," with little or no local enforcement of conservation laws. Its long and unpatrolled coastline is used by smugglers, who load tortoises onto small boats at night, with little fear of arrest (Webster 1997). Although some enforcement of capture bans takes place in the range of the Radiated Tortoise, local people have learned to avoid arrest.

The contrast between the attitudes of local people toward the Plowshare Tortoise in the north, where education programs have been carried out by the Jersey Wildlife Preservation Trust, and the south, where no strong program exists to protect the Radiated Tortoise and other wildlife, could not be more dramatic. In the south, poaching Radiated Tortoises and other reptiles is considered an accepted form of revenue by the extremely poor people of the region. At local bars and restaurants, Webster was approached by people who offered to produce a rare snake within 24 hours. Snakes are a favorite animal for smugglers because they can be secreted in small bags and placed in luggage or, if they are small enough, in pockets. He refused a boa, which was offered at $300 and could be sold for $2,000 in the United States (Webster 1997).

Webster exposed a large-scale and fairly open trade in Radiated Tortoises in local markets within the range of these tortoises. He visited a woman who was reputed to have many of these tortoises for sale. She showed him 24 Radiated Tortoises which she kept ready for sale to anyone who would pay the right price; they were crowded into a make-shift pen in her living room, stacked two and three deep in filthy conditions (Webster 1997). They grunted and made hissing sounds when disturbed, scratching and scrabbling against one another and the pen sides; their shells were covered with dust, and most appeared to be sickly (Webster 1997). The woman tossed the tortoises back into the pile after handling them. She claimed that she sold them to local people for $1.35, and to outsiders for $4 or more, depending on how many tortoises she had at the time (Webster 1997). She also admitted supplying a smuggler who arrived once a week in a canoe at a remote beach with any Radiated Tortoises she had in stock (Webster 1997).

These tortoises are absurdly easy to collect in the wild, living in open shrubland and moving so slowly that they can be picked up as easily as rocks. Webster witnessed the capture of one mature tortoise which Benjamin, one of the collectors, located in the shadow of a boulder. When he approached, the tortoise hissed and tried to crawl beneath bushes, but it was easily grabbed, and he flipped it on its back; soon he caught two other adult tortoises who had a baby the size of a small stone wedged beneath them in an apparent attempt to protect it (Webster 1997). Collectors wrap string around the tortoises™ shells to form handles for carrying them. When they met at the end of the day, they had taken 54 mature tortoises and many young ones, making it a "banner day" (Webster 1997). The occasional presence of enforcement officers and World Wildlife Fund (WWF) representatives did not seem to present any anxiety of threat of arrest to the collectors (Webster 1997).

Each Radiated Tortoise is worth at least $2,000 once smuggled out of Madagascar, and those with unusually exquisite patterns bring as much as $10,000 (Webster 1997). Benjamin later admitted that he was aware that the tortoises were

becoming rarer and that their range had shrunk in recent years; he also knew that many were very old, probably older than his own 53 years. It was obvious that the tortoises would soon be gone, but he believed this was his only potential income source; he was uncertain about how he would make a living when there were no more Radiated Tortoises (Webster 1997).

Some of the smuggled Radiated Tortoises leaving Madagascar have been seized by importing countries. In May 1992, for example, a Dutch citizen arriving from Madagascar was stopped by Customs at Roissy Airport in the Netherlands in possession of 46 Radiated Tortoises as well as 14 bamboo lemurs of several species and seven endangered Madagascar Boas (*Acrantophis madagascariensis*); the animals were confiscated and returned to Madagascar (TRAFFIC 1992). In 1998, a Radiated Tortoise was among many rare tortoises seized in Belgium as they were being imported, and U.S. authorities, under fiOperation Chameleon,fl an undercover investigation of trafficking in illegal Madagascar reptiles, seized Radiated Tortoises from an American reptile dealer in Miami. In May 1999, French Customs officers seized 450 tortoises smuggled by three Malagasy citizens living in Paris (TRAFFIC 1999b). Among them were 120 Radiated Tortoises; the suspects were not arrested (TRAFFIC 1999b).

Most ecotourism on the island has been developed for viewing lemurs, chameleons and birds, but the Radiated Tortoise and its extraordinary habitat of endemic plants have the potential of attracting many tourists. Also living in this tortoise's habitat are spectacular sifakas, many unusual birds, and other reptiles. In Beza-Mahafaly Reserve, scientists are studying the ecology and longevity of these tortoises, as well as searching for a permanent form of marking that would make them unattractive to collectors. The Radiated Tortoise could be conserved while helping local people like Benjamin. Grants from international organizations could finance jobs held by local people, such as ex-poachers, to protect the tortoises and serve as wardens. Former collectors could help educate schoolchildren and local people about protecting Radiated Tortoises and other wildlife. Organizations, such as Earthwatch Institute, might sponsor research to study the status of these tortoises. The presence of scientists would pose a deterrent to poachers.

Two other endemic tortoises, the Spider Tortoise (*Pyxis archnoides*) and the highly endangered Flat•shelled Tortoise (*Pyxis planicauda*), are much smaller, about 5 or 6 inches long (Preston•Mafham 1991). The latter tortoise is restricted to a forest of only 40 square miles, and a captive•breeding program is attempting to prevent its extinction. Both these tortoises lay only a single, large egg (Preston•Mafham 1991). These tortoises are also in demand by reptile collectors. In August 1996, six men were indicted after being arrested with four Spider Tortoises in their luggage at the Orlando International Airport in Florida. They were part of a smuggling ring supplying rare reptiles to collectors. In 1999, 330 Spider Tortoises were seized along with Radiated Tortoises in the case cited above (TRAFFIC 1999b).

The Madagascar Big-headed Turtle (*Erymnochelys madagascariensis*), is an endangered freshwater species listed in the *2000 IUCN Red List of Threatened Species* and on Appendix II of CITES. This turtle is related to South American river turtles, another link that may date back to the time before Madagascar drifted away from Gondwana. The Jersey Wildlife Preservation Trust began a breeding program for these turtles in 1999 with the objective of releasing young turtles back into the wild after educating local people.

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Madagascar is home to two•thirds of the world's chameleons--at least 62 species--more than any other country (Tyson 2000). Among the island's endemic chameleons are the world's smallest and largest species. The smallest, *Brookesia minima*, is only 1.3 inches long, while the largest, *Furcifer oustaleti*, measures 27 inches in length (Preston•Mafham 1991). Their conical eyes, moving independently, can look forward and backward at the same time, swiveling almost 180 degrees in either direction (Preston-Mafham 1991). This adaptation, processing totally divergent information spontaneously, would confuse most vertebrates, but chameleons, even very young ones, are adept at using these dual periscopes to locate insects and other prey. They hold onto the thinnest branch with their prehensile tails, and with

long, thin legs bent at the knees, they walk in an odd back-and-forth swaying motion that resembles leaves moving in the wind. Their chunky bodies and spindly legs give them an awkward appearance, but they are superbly adapted to catching their prey by unfurling a long, sticky tongue--curled upside their mouth--with lightning speed, nailing an unaware insect with astonishing accuracy.

Their camouflage coloration, which varies greatly from bright greens, mottled browns, reds and blues, helps protect them from avian and mammal predators. Contrary to general opinion, chameleons do not change colors as they move about in the trees or on the ground to match their background. When they suddenly change colors, it is as a territorial or sexual display meant for other chameleons (Preston-Mafham 1991). Some species have horns and other protuberances, giving them the appearance of miniature dinosaurs. A few species show sexual dimorphism, or a physical difference between the sexes. The contrast can be so striking that some were considered separate species when first identified (Burger and Price 1996). In one species, for example, the female is black and yellow, and the male a mottled brown and white (Burger and Price 1996).

Chameleons are heavily exploited by collectors who capture them for sale in pet stores around the world, threatening them. Collectors will pay $1,000 or more per animal for rare species. This trade, which involves thousands of individuals, has caused declines in many species. The Malagasy government has banned trade in most species, but enforcement is not strong. One chameleon, *Chamaeleo brevicornis*, of which 795 were exported in the first six months of 1990, is restricted to only a few areas of primary forest (Behra 1993). An ongoing study will evaluate whether to allow trade in the commoner species. Chameleons captured and shipped abroad for the pet trade suffer very high mortality as a result of inhumane transport conditions and inadequate care in pet stores and people's homes. They require special conditions of temperature and humidity, and many have specialized diets. In short, they are not suited to being house pets. In the care of specialists, they can be kept alive, but most captive breeding has been unsuccessful. Some of the rarer species, such as the beautiful blue-green Parson's Chameleon (*Chamaeleo parsonii*), which can reach lengths of more than 20 inches, have not been bred to the second generation**,** and mortality is high. All chameleons are on Appendix II of CITES, which requires export permits, but none has been listed on Appendix I of CITES, which would ban commercial trade.

Although some chameleons have adapted to disturbed habitats, such as weedy fields and shrub landscape, the majority favor natural habitats. The small *Brookesia* chameleons, of which one species is listed by IUCN as Vulnerable (Hilton-Taylor 2000), require undisturbed, primary old-growth forest. Three other chameleons, all *Furcifer* genus, are listed as Vulnerable by IUCN. All are in decline, approaching endangered status.

Although many Malagasy regard chameleons as ugly porters of bad luck (Burger and Price 1996), for tourists, they are the second most popular animals, after lemurs. Some Malagasy, aware of the fascination with which chameleons are held by tourists, capture them and offer them for viewing or sale.

Another lizard being captured for the pet trade is the extraordinary 4-inch-long Leaf•tailed Gecko, *Uroplatus fimbriatus*, a true master of camouflage. Resting during the day with its head tight against a tree trunk, an elaborate lacy fringe along the underside of the body allows it to melt into the tree, while its skin is patterned to resemble tree bark. Even its golden eyes are streaked with tiny dark lines that imitate bark. With broad, flattened front feet splayed out against the bark and hind legs held vertically under a spatula•like tail, it becomes virtually invisible (Preston•Mafham 1991). If discovered, however, it has a defense. Opening its mouth wide to reveal a crimson•red tongue, it raises its tail vertically and emits an ear-splitting screech, no doubt intended to be a fearsome display (Preston•Mafham 1991, Tyson 1994). Malagasy boys have discovered the haunts of the Leaf-tailed Geckos, and capture hundreds--thousands by their accounting--for sale to foreign middlemen who pay them less than $1. They are sold in the United States for $250 a pair (Tyson 1994, Tyson 2000). On Nosy Be island off the northern coast, schoolboys claim to have captured 40,000 over the past six years (Tyson 2000). A threatened gecko, Standing's Day Gecko (*Phelsuma standingi*), is native to the spiny forests of the south and is one of the most coveted by collectors (Tyson 2000). It is hunted out of many areas because Malagasy have captured hundreds, receiving $1.20 per gecko, while reporting only a few to authorities (Tyson 2000). It is on CITES Appendix II, and sells in the United States for

$80 to $200 apiece (Tyson 2000). Most species of geckos bring the village collectors only about 3 U.S. cents, while the exporter receives $9 to $13 and U.S. retailers get $75 or more (Burger and Price 1996). In most cases, these pet reptiles live a very short time, and represent a mere toy to the consumer.

The export trade in live lizards involves an enormous number of animals. One gecko, *Phelsuma serraticauda*, was known only from a few museum specimens until 1,360 specimens were chronicled as exported during the first six months of 1990 for the pet trade (Behra 1993). During this same period, 22,837 lizards--geckos, *Phelsuma* genus, and chameleons, *Chamaeleo* genus--were exported from Madagascar (Behra 1993). Between 1986 and 1991, almost 145,000 lizards of 17 species were exported; of these at least 38,325 were chameleons of 21 species (Burger and Price 1996). Many of these are species that are endemic to restricted areas, or threatened in the wild. The U.S. Fish and Wildlife Service™s fiOperation Chameleonfl succeeded in arresting 19 people in 1998, among whom was a major Malaysian smuggler and an American, Tommy Crutchfield, who was arrested at Miami International Airport with suitcases full of rare snakes, tortoises and lizards. In another case, a Canadian and a Dutchman were arrested at Chiang Kai-shek International Airport in Taiwan with numerous chameleons and geckos, including some threatened Standing's Day Geckos.

Several gecko species have extremely limited ranges. A newly described leaf gecko, *Uroplatus malama*, is known from a single specimen taken in a remnant of lowland rainforest in southeastern Madagascar (Burger and Price 1996). Only two specimens of a closely related species, *Uroplatus malahelo*, exist, native to a small patch of forest in the south (Burger and Price 1996). When discovered, its habitat was being logged, and the species may already be extinct (Burger and Price 1996). An extremely rare lizard, *Zonosaurus boettgeri*, known from two specimens that were taken in the 1890s and subsequently disappeared, has been rediscovered on the island of Nosy Be by herpetologist Chris Raxworthy and volunteers from Earthwatch Institute (Tyson 2000). The two individual lizards were killed as specimens upon rediscovery (Tyson 2000).

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Among Madagascar's 80 types of snakes--all non-poisonous--are three boas, whose closest relatives are found in South America (Burger and Price 1996). They are thought to be among the island's most ancient inhabitants, resident since the early breakup of Gondwana (Preston•Mafham 1991). All are considered Vulnerable by the IUCN (Hilton-Taylor 2000): Dumeril's Boa (*Acrantophis dumerili*), Madagascar Boa (*Acrantophis madagascariensis)*, and the Madagascar Tree Boa (*Sanzinia madagascariensis*). The first two are Madagascar's largest snakes, reaching almost 6 feet in length; Dumeril's Boa is restricted to the south and southwest, while the Madagascar Boa is found in the north and northeast (Preston•Mafham 1991). Both species require humid habitats along streams and watercourses. Placid and slow•moving, they are often killed or captured by local people. The Madagascar Tree Boa is smaller and more common, shaded in delicate grayish-green with a purplish•blue tinge. Little is known of any of these species' life histories and diets (Preston•Mafham 1994). A very rare and possibly extinct snake, *Pararhadinea albignaci*, is known only from a single specimen picked up, dead, off the road in eastern Madagascar in 1970. This species has never been seen alive in its forest home (Preston-Mafham 1991).

One of the most extraordinary snakes in the world, *Langaha nasuta*, mimics a dry, pencil-thin twig to camouflage itself among the leaves. The female's nose is extended into a leaf•shaped structure adorned with scales and small tooth•like projections, while the nose of the male is elongated, tapering into a sharp point to resemble a thorn (photo in Preston•Mafham 1991 and Lamar 1997).

A smuggling operation involving hundreds of Madagascar reptiles was exposed in August 1996, when six men were charged with conspiracy to smuggle rare Madagascar reptiles into the United States and Canada. According to the U.S. Justice Department, two men were arrested at Orlando International Airport in Florida with 61 Madagascan tree

snakes in their suitcases that were to be sold at a large reptile breeders show in Orlando (Reuters 1996). Four Germans, one Canadian and one South African were indicted. Simon Harris, the South African, had $100,000 worth of rare reptiles in his luggage; he cooperated to implicate the other suspects, who are still being sought (Reuters 1996). These smugglers shipped snakes and tortoises, concealed in suitcases, from Europe to Canada and the United States and received payment by international wire transfers. Most of the snakes and tortoises were listed on CITES. In 1998, 26 Madagascan Tree Boas were seized in Belgium, and an American reptile dealer was caught by the U.S. Fish and Wildlife Service with the latter species and Dumeril's Ground Boas in his luggage at Miami International Airport (TRAFFIC 1999a).

The sea turtles inhabiting Madagascar's coastal waters are heavily exploited in spite of their listing on Appendix I of CITES. A survey in 1971 estimated that 13,000 were killed along the west coast alone (Burger and Price 1996). Little is known of their present populations.

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Some 176 species of amphibians, all frogs, have been named and described (Mittermeier *et al.* 1999). Raxworthy estimates that there are another 124, many of which have already been found but not yet described scientifically (Tyson 2000). Salamanders and toads are absent from Madagascar. All but two frogs are endemic, one of which was introduced from Asia by French colonialists as a gourmet food source (Burger and Price 1996). The majority are native to rainforest environments, the most endangered type of habitat on the island. In one such area, a montane rainforest in the Andasibe region, 90 species are native--the highest diversity of frogs in the world (Burger and Price 1996). Since 1990, 13 new species of a single, colorful genus, *Boophis*, have been described, and others await naming by scientists (Burger and Price 1996). A candidate for the world's smallest frog--and perhaps the world's smallest vertebrate--is a minute frog, *Stumpffia pygmaea*, which measures less than 3 millimeters in length (0.117 inches) (Burger and Price 1996). This frog lays its eggs in foam nests hidden among leaves on the forest floor, and the tadpoles grow into froglets without ever feeding (Burger and Price 1996).

The most spectacular Malagasy frog may be the bright red Tomato Frog (*Dyscophus antongili*), which secretes poisonous white mucous when threatened. Some authorities consider the species to be endangered (Bauer 1995), while the *2000 IUCN Red List of Threatened Species* lists it as Vulnerable. To protect it from trade, it is listed on Appendix I of CITES. Fat and squat, this toad-like frog is large enough to cover the palm of a hand (Preston-Mafham 1991). Tomato Frogs have a very restricted range in the region of Tamatave on the east coast; some live in plantations, where pools of water gather, and even in garden ponds (Preston-Mafham 1991). Collectors, pet dealers and zoos have offered thousands of dollars for these frogs, and illegal shipments containing 40 or more Tomato Frogs have been confiscated.

One study entitled "The Export of Reptiles and Amphibians from Madagascar," by Olivier Behra (1993), chronicled the extent of exploitation of frogs. In 1988, 230 frogs of the genus *Mantella*, endemic to Madagascar, were exported. The demand increased, causing exports to rise astronomically to 11,058 in 1989; in the first six months of 1990 alone, almost 11,000 were exported, mainly to Denmark and other European countries, the United States and Japan (Behra 1993). These brightly colored little frogs are sold as pets and to decorate terrariums. The most popular Madagascar frog in this trade is the tiny Golden Mantella (*Mantella aurantiaca*), of which 3,237 were exported in the first six months of 1990 (Behra 1993). This frog is restricted to eastern Madagascar, and is apparently rare and declining (IUCN 1994). It lives in pandanus swamps in rainforests, which are rapidly disappearing, and no part of its habitat has been set aside in a reserve (IUCN 1994). Unlike most frogs, the Golden Mantella is slow-reproducing (IUCN 1994). In the 1990s, 3,000 to 6,000 were exported annually from Madagascar, and in 1994, two proposals sought to list this species on CITES, one on Appendix I and the other on Appendix II. The latter proposal succeeded, which is unfortunate, since it allows the trade to continue. The *2000 IUCN Red List of Threatened Species* lists the Golden

Mantella as Vulnerable (see photos of gold and red phases of this species in Lamar 1997).

In 1998, two people were arrested in Taiwan trying to smuggle frogs of two *Mantella* species (*Mantella madagascariensis* and *Mantella aurantiaca*), along with some Madagascar lizards. Another seizure of 50 Mantella frogs occurred at Zaventem Airport in Belgium in 1998 as they were being smuggled from Madagascar (TRAFFIC 1999a). Such seizures involved shipments without the proper export permits. Appendix I listing under CITES would provide greater protection.

The Biological Wealth of an Impoverished Country: Invertebrates

Like the rest of its fauna, Madagascar's invertebrates are extraordinary. One insect from the age of the dinosaurs, the Giraffe-necked Weevil (*Trachelophorus giraffa*), has an elongated neck which rises vertically, then makes a right-angle turn and extends horizontally, and ends in a tiny head with furry antennae. Amazingly, this insect has counterparts in New Zealand known as giraffe weevils (Molloy 1994). This may be explained by the fact that New Zealand was also part of Gondwana prior to its breakup (Molloy 1994). Other ancient species include the 100 species of hissing cockroaches. Some are far larger than any other cockroach species in the world; their heavy bodies resemble long-extinct trilobites. The largest species measure up to four inches long, and thousands are exported for the novelty pet trade and for zoos. When touched, they hiss loudly, and males aggressively charge one another with their armored, knobbed shields (Preston-Mafham 1991).

One of the richest land-snail faunas in the world is native, with more than 380 species named so far, 361 of which are endemic and differ greatly from land snails in Africa (Preston-Mafham 1991). Many are threatened, however, by introduced African Giant Snails (*Achatina fulica*) and several other non-native snails introduced to control the African Giant Snail, but threatening native species instead. One native snail, *Tropidophora deburghiae*, is considered endangered by some authorities. Brilliantly colored slugs, or shell-less snails up to 6 inches long, striped in black-and-red or yellow-and-brown, live on the damp rainforest floor (Preston-Mafham 1991). Many have limited distributions and can be easily eliminated by habitat destruction (Preston-Mafham 1991).

An extremely ancient family of spiders, Archaeidae, first described from a specimen frozen in amber several million years old, has seven species on Madagascar, one in South Africa, three in Australia, five in New Zealand and one at the tip of South America; these species appear to be vestiges from the ancient supercontinent (Preston-Mafham 1991). The Archaeidae spiders have strange, grotesquely shaped bodies, visible only through a microscope since they are only 0.14 inches long; they live among leaf litter on the ground (Preston-Mafham 1991). Some Madagascar spiders are extremely bizarre, with shapes that resemble bat-winged leaves, bright red thorns, or mottled brown lumps on logs (Preston-Mafham 1991).

Millipedes on Madagascar reach 6 inches and exude droplets of poison when attacked; Brown Lemurs have found ways of avoiding this toxin and feed on them (Preston-Mafham 1991). Shield-bugs, or stink-bugs, of the family Pentatomidae, have 220 species on Madagascar, many of which are brightly colored in reds, oranges and blacks; 120 species of water bugs, of which 80 percent are endemic, and a variety of assassin bugs add to the rich insect fauna (Preston-Mafham 1991). About 20,000 beetle species, including 500 species of endemic jewel-beetles, are native to Madagascar. Jewel-beetles, with their colorful, metallic bodies, appear during the rainy season in southern and western forests (Preston-Mafham 1991). Many species of scarab beetles, among which are dung beetles, are also native to Madagascar; one endemic genus, *Helictopleurus*, roll the dung balls into their nests and lay their eggs in them (Preston-Mafham 1991).

Madagascar's butterflies, totaling 300 species, are not as diverse as in some parts of the world, such as the Tambopata Natural Reserve in Peru, which has 1,300 species. This may be because they colonized the island fairly recently.

Another possibility is that many species have faded into extinction, leaving no trace, when the plant species upon which they depended were driven to extinction by habitat destruction. Since 80 percent of the island's forests have been cut, hundreds or thousands of species may have disappeared without a trace millennia ago. One Madagascar butterfly, a pale cream-and-black Swallowtail, *Papilio mangoura*, is hotly pursued by collectors because of its rarity (Preston-Mafham 1991). Several butterflies of the Nymphalidae family, or Fritillaries, are threatened, as are two species of the family Acraeidae.

In the 19th century, Charles Darwin learned of a spectacular, white Madagascar orchid (*Angraecum sesquipedale*) that had an extremely long, nectar-bearing tube dangling down from the flower. He reasoned that it could be pollinated only by an insect that could reach its nectar. He guessed that it might be "some huge moth, with a wonderfully long proboscis." Entomologists verified his belief with the 1903 discovery of the hawkmoth, *Xanthopan morgani praedicta*. This moth has a 9-inch tongue that it keeps wound in a spiral in its mouth, unfurling it to reach the nectar of this particular orchid. In a similar arrangement, another orchid (*Angraecum arachnites*), exudes a strange odor that attracts only one pollinator, the rainforest hawkmoth, *Panogena lingens* (Preston-Mafham 1991). The nectar at the base of this orchid's long, twisted tube can be reached only by this single species of moth--and not even every individual, but only one race of this moth which has a long, tapered proboscis (Preston-Mafham 1991). These species co-evolved, and should the moths become extinct, the orchids would have no pollinators and would follow them into extinction. Another unusual moth, the huge Comet Moth (*Argema mittrei*), is one of the largest moths in the world (Preston-Mafham 1991).

Preserving Madagascar's Natural Wonders

This fourth largest island in the world is, in many respects, a minicontinent. This evolutionary treasure-house is of great importance from a worldwide perspective. Madagascar's diversity of life forms is so great that as many as 200,000 species, most of them undescribed, may be native, of which an estimated 150,000 are endemic species (Daley 1997). The habitat loss is proceeding so rapidly, however, that the underfunded biological assessment studies will be unable to appraise this biological wealth before it disappears before their very eyes. Logging and burning have reduced the forested area from 120,000 to 20,000 square miles; this destruction still consumes vast areas each year (Daley 1997). It is estimated that all the remaining accessible forests will disappear within the next 35 years (Sayer *et al.* 1992). With the impending loss of these treasures, many conservationists and scientists consider Madagascar the world's most threatened natural area (Sayer *et al.* 1992).

Less than 5 percent of Madagascar is protected in reserves and parks. Even if these lands remain intact, they represent too small a percentage of forest to preserve the island's genetic heritage. Other than Masoala National Park, which encompasses most of an entire peninsula, some 840 square miles, most reserves are relatively small--islands of forest surrounded by denuded land. Should all surrounding forest be leveled, these isolated fragments would not be sufficient to prevent genetic impoverishment, inbreeding, and eventual extinction of the very species the reserves were meant to protect. Recent research in the Amazon has shown that forest fragmentation results in extinctions, in direct relation to the size of the reserve (Peters and Lovejoy 1990). The larger the reserve, the fewer extinctions. For this reason, Masoala National Park is receiving special attention from scientists. Stanford University's Center for Conservation Biology is analyzing a Geographic Information System (Kremen 1998). So far, this research has revealed that forests on the eastern border of the park are the most threatened, with a likelihood that they will be completely burned away within 25 years (Kremen 1998). The borders of the park were delineated according to the results of biological surveys, a method that is so new that it has not even been used in the United States. Claire Kremen of the Wildlife Conservation Society, with additional support from the National Geographic Society, worked with a Malagasy entomologist and two American ornithologists to conduct detailed biological species diversity studies in this rugged terrain (Kremen 1998). Five new species of butterflies and many other insects were discovered. Each had its own micro-habitat, endemic to that area. Habitats included in the national park are lowland rainforest; cloud

forest and montane heath; coastal and seasonally flooded forest; mangrove; marsh; estuary; bay; lagoon; and coral reef. Lemurs and a vast array of wildlife and plants will benefit from this new park.

Masoala National Park will not displace villages but will conduct education programs and involve them in the conservation of local wildlife. The Missouri Botanical Garden is also involved in the management of Masoala National Park, helping to inventory its rare plants and working with local people for non-destructive agricultural and fisheries industries. Work is also proceeding to stop the cutting of forests for firewood on Masoala and to provide public education on land use (Sayer *et al.* 1992). Some 300 or so villages exist within or nearby Masoala National Park, and the cooperation of the local people is crucial to the success of this park. The final plan for the park involved a compromise in which some cutting of four relatively fast-growing trees, including rosewood, would be allowed. Local communities, which will profit from the products, will be allowed to harvest palm seeds and butterflies. This will prevent the slash-and-burn destruction that was eating rapidly away at this forest (Kremen 1998). This park's endemic plants and animals, including the Red Ruffed Lemur, which exists only in the park, rely for their survival on the protection of this last sizeable rainforest. It will represent an experiment in conservation management that will have serious consequences should it fail. It is, however, one of the first times that ecological rules are being worked out with large numbers of local people to help protect such a large area. Elsewhere in Madagascar, similar projects are in the works.

Many of Madagascar's rarest species are not protected in any reserves, however, and may soon be lost. Reserves and parks, the last refuge for many species, are regularly pillaged for trees, and wildlife is killed or captured. A herpetologist surveying in Bemaraha Reserve, in the western part of the island, discovered a pile of illegally cut trees that had been marked with red paint as part of a botanist's study by the trail in 1996 (Holmes 1997). This is not an isolated occurrence. The native wildlife and plants are among the most endangered in the world. More than 124 vertebrate species are listed in the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000), as well as 306 species of plants (Walter and Gillett 1998). While this crisis is occurring, new species of lemurs, reptiles, invertebrates and plants are being discovered, making the preservation of the environment all the more urgent. Obviously, the amazing biological diversity of Madagascar has not been fully assessed and may be far greater than previously thought.

Several species thought long-extinct are rumored to survive, adding even more mystery to the picture. Many Malagasy have told scientists of having seen an animal that might be a pygmy hippopotamus. Shown a picture of an African Common Hippopotamus, they have said that it was similar, but had floppy ears, uncloven hooves, dark skin, except for pinkish areas around the eyes and mouth, and was the size of a calf or small cow (Tyson 2000). As recently as 1976, a man told biologists of having seen and heard one grunting; many unsolicited, independent accounts from Malagasy have agreed on these details (Tyson 2000). They call the animal "kilopilopitsofy," and many are afraid of being chased by it (Tyson 2000). The Common Hippopotamus of Africa also grunts and kills more people than any other animal on the continent.

A long-lost primate, ground-dwelling and the size of a 7-year-old child, has also been reported by several Malagasy (Tyson 2000). This may be the same animal that was described to primatologist Alison Jolly (1980). A Malagasy told her that he had been given a young lemur of a type he had never seen before. This lemur had very dark fur, walked on its hind legs, one foot after the other, rather than hopping like a sifaka, and had a flat face different from the pointed muzzles of living lemurs. After only two months, this lemur died, and its skeleton was buried in an unknown place (Jolly 1980). An old man recently told a similar story of having seen such an animal in 1952. Called the "kidoky" by others who have seen it, it has a dark coat with white spots above and below a flat, round face. When alarmed, it flees by leaping forward in short hops like a baboon. Its call was described as a long, single whoop, and other villagers who had seen the animal said it was solitary (Tyson 2000). Scientists have said that if it exists, it might be an *Archaeolemur* or *Hadropithecus* (Tyson 2000). The fact that their descriptions seem so similar to species known to have existed makes them all the more intriguing.

Alarm calls about the impending demise of Madagascar's natural world have been sounded for decades (Jolly 1980,

1988; McNulty 1975; Preston•Mafham 1991; Tyson 2000). Visitors to the island are united in their descriptions of a ravaged, eroded and deforested land. Jacques•Yves Cousteau and his team visited the island for a television special aired in 1995. As they sailed toward Madagascar, they were stunned to see huge, wide, red stains of eroded soil in the water, emanating from the island's rivers, and wisps of smoke from burning forests. These red rivers are bleeding the island's life blood, its topsoil. They are so pronounced that they are among the few natural phenomena on Earth visible from orbiting space craft. Cousteau's helicopter flights over the central plateau revealed a landscape among the most devastated on the planet. A research team sponsored by Earthwatch Institute described the island from the air, "Two features of the landscape stood out even from 10 kilometers up: barrenness and smoke" (Tyson 1994).

Although erosion remains a major problem, some progress has been made to stop it (Morell 1999). Erosion costs Madagascar between $100 million and $290 million per year, caused mainly by the continued slash-and-burn agriculture (Tyson 2000). It has been extremely difficult to convince many Malagasy that the last of the forests will disappear within a generation if they do not seek alternative means of growing crops. To that end, Cornell University's International Institute for Food, Agriculture and Development, run by Norman Uphoff, has been helping farmers in the vicinity of Ranomafana National Park (Tyson 2000). These desperately poor farmers have no electricity or plumbing and struggle to feed large families on soil that is leaching its nutrients. Norman Uphoff discovered that the native Wild Ginger plant had high concentrations of phosphate, and he encouraged its use as fertilizer (Tyson 2000). By supplying seedlings and information, the Cornell program also has helped establish fish farms. Their agronomists have advised farmers to mix crops and to plant certain species in order to keep the soil rich and retard erosion; they have supplied seedlings (Tyson 2000). This agricultural advice has been helpful, but because some rural people have so many children, many are unable to produce enough crops to feed their families (Tyson 2000). Other projects involve encouraging rice cultivation with more suitable seed varieties, improved irrigation systems and application of fertilizer (Garbutt 1999). Using native bees in honey-making is also being taught to the Malagasy, who often fell old-growth trees to obtain honey (Garbutt 1999). The Kew Botanical Gardens in London and Britain's Royal Palm Society are researching the marketing of seeds from some native palm trees (Terry 1996).

International aid organizations could help preserve forests by donating fertilizer so the Malagasy would not need to practice slash-and-burn when forest soil ceases to produce crops. The urgent task of supplying the Malagasy people with methods of producing food and fuel in environmentally non-destructive ways has just begun. Villagers would be more likely to preserve trees now cut for firewood if they were provided with solar cookers or given propane tanks for fuel. Bio-gas, or methane, produced by animal dung and sewage, could be used to provide fuel and fertilizer. Such projects have been launched by international agencies in some countries of Central Asia.

Madagascar's human population is growing at a rate of 3.1 percent per year and reached 12,596,000 in 1992 (55 persons per square mile) (Anon. 1994). By 1995, it had grown to 13.9 million (61 persons per square mile) (McNeil 1996b). Another increase to 14,462,509 people (64 persons per square mile) was registered in the 1999 *World Almanac*. The *2001 New York Times Almanac* noted a population of 15,506,472, based on a July 2000 estimate. Thus, 3 million people were added to the population in just eight years. Along with the original Asians, more recent immigrants from Africa, India, Pakistan, China, Europe, and Arab countries add to the diversity. They have long since passed the carrying capacity of the land, and rice must be imported to feed the people. As one of the world's 12 poorest countries, Madagascar's external debt is approximately $4.25 billion. Average annual income is only $780 (NYT 2000). The unemployment rate is about 33 percent, and 51 percent of children are malnourished, according to a study by USAID (Tyson 2000). The literacy rate is 46 percent, and only 42 percent of children attend schools; 70 percent of children ages 6 to 9 have had no formal education (Tyson 2000). Jacques Cousteau's team filmed hordes of desperately poor people as they combed dumps for scraps of metal and food. Some people even live in these dumps in holes they have dug in the soil. Such scenes are symptoms of extreme overpopulation and rampant poverty that can also be seen in parts of Brazil and Asia.

One of the reasons that illiteracy is so high in Madagascar is that millions of people must spend their days searching for food, water and firewood, requiring the help of their children, who are then unable to attend school. In general, foreign corporations have looted the island's resources, leaving no economic base that would help the people as a

whole. One U.S. company, the Esso Corporation, is owed $25 million by the Madagascan government and demanded payment in spite of the country's cash reserves of less than $2 million (McNeil 1996b). Because of the country's debt levels, the World Bank and the International Monetary Fund are now in charge of its finances (McNeil 1996b), a potentially dangerous situation for both the people and the environment. On the positive side, a "Debt for Nature" swap was carried out in Madagascar, in which a portion of the foreign debt was exchanged for the establishment of nature reserves and parks.

To date, efforts to slow the population growth rate are still in their early stages. A program that addresses population growth, based not on threats or punishment, but on persuasion, was launched by Population Communications International (PCI) of New York City in 1996. As the organization has done in other countries, it trains local people to create communication programs for radio and television with a message that limiting family size is advantageous. The majority of the population on the island lives in cities and has access to these media. The programs, described as "soap operas" by PCI, create melodramas with characters the audience can identify with, who act out dramas. The characters in these dramas come to realize that different behavior, such as having fewer children, will result in positive changes in their lives (Ryerson 1994). In many cases, this involves elevating the status of women, and convincing men that women must be allowed to make decisions about their own reproduction (Ryerson 1994). PCI is cooperating with organizations that are actively trying to conserve the wildlife of Madagascar, such as Conservation International and the African Wildlife Foundation. Ranomafana National Park began a family planning center in 1994 to help the people of the region, many of whom have as many as 14 children, of which 62 percent are underweight and 17 percent malnourished, according to a study by the University of North Carolina (Tyson 2000).

Madagascar is a magnet for scientists from around the world and has been the recipient of millions of dollars in foreign aid and grants from international conservation agencies. Conservationists are initiating many highly inventive and effective programs to interest the Malagasy in conservation and employ them in biodiversity work. Environmental education is a key to the future of Madagascar, and programs are being carried out at Beza-Mahafaly Reserve. This protected portion of endangered spiny desert and shrubland was established when the local Mahafaly people agreed to donate the land, and funds were raised by Alison Richard, a Yale primatologist, for a training program for Malagasy scientists (Tyson 2000). Patricia Wright has set up a similar program in which Malagasy students complete master's theses based on wildlife research in Ranomafana National Park, and some students travel to the United States to receive advanced training in biodiversity and environmental protection (Tyson 2000). They will help guide the country in new directions in the future. It also opens new worlds to these students, who, in turn, will make young people aware of the natural treasures in their country. Schools that Patricia Wright has helped establish in the area of the park teach environmental education to young people. Others are also helping introduce this subject to children. Josephine Andrews, a Scottish scientist studying Black Lemurs in Nosy Be since 1988, teaches children about the lemurs with the help of a Malagasy named Julien, who guides people around the forest preserve (Tyson 2000). "If the kids are really into it, then the adults will switch on as well," she said (Tyson 1994). Forests are the key to the future survival of the island and its people, and an education program aimed at rural people, teaching the value of trees in preventing floods, landslides and in maintaining the flow of rivers and streams, could save countless trees.

Scientists--both Malagasy and foreign--working on the island, could share their findings by talking with local people about the uniqueness of Madagascar's natural world. Ornithologists with the Peregrine Fund, who rediscovered the Red Owl and taught local schoolchildren about the species donated money from bird-watchers to the school, provided such an example. Scientists typically conduct research and depart without having taught local people about their findings. Villagers near Ranomafana National Park were so interested in learning about research results that they asked Wright for copies of reports. She began a bimonthly newsletter, in the Malagasy language, describing the natural history of the park (Tyson 2000).

Films and books about Madagascar's wildlife and plants tend to be distributed only in foreign countries, and never translated into Malagasy. Translations of books and subtitled films could be shown to schoolchildren to introduce them to Madagascar's tremendously interesting and beautiful natural world. It is ironic that Westerners may be more familiar with lemurs and chameleons that most Malagasy. Some projects for the future might include donation of solar

collectors and windmills to supply power to rural people. This could elevate their standard of living and cut back on firewood collection for fuel. Donation of projection and video equipment to regional schools provided with electricity would help them appreciate their natural heritage through viewing nature films of Madagascan wildlife. Satellite dishes would facilitate communication with people around the world through the Internet.

The government of Madagascar developed a 20-year National Conservation Strategy and Environmental Action Plan as long ago as 1984. In 1986, a survey of protected areas began with the aim of implementing management plans for priority protected areas and recommending new protected areas, as well as training Malagasy people to work in reserve management and conservation biology. The government has been working to create a sense of pride and ownership in the nation's biodiversity through this program (Morell 1999). The President of Madagascar has stated that the environment is important, a key to whether foreign scientists and tourists will be able to come to the country and aid in its conservation in the future (Tyson 2000). The World Bank and various organizations funded this Environmental Action Plan with $168 million for its first five years (Tyson 2000). This has resulted in many biological studies, education of a growing number of Malagasy for conservation work and a Biodiversity Planning Centre (Sayer *et al.* 1992). The Geographical Information System database is a cornerstone of the government program, concentrating data from all fields to help establish conservation priorities (Tyson 2000). Conservation International has an office in the capital and is contributing to biological inventory data, as it has in other countries, as well as conducting research on particular species and data management. It coordinates its work with local organizations and trains Malagasy scientists (Sayer *et al.* 1992).

Ecotourism is another budding industry, and Madagascar is one of the few countries in the world to share park fees with local people. As a result of an initiative put forth by a Malagasy non-governmental organization, the National Association for the Management of Protected Areas, one-half of all fees are given to local people (Tyson 2000). Ninety-three villages in the Ranomafana National Park area received about $10,000 in a recent year from park fees; a committee designated by the villages decides how to spend the money. In 1995 they bought seeds and built campgrounds, a crafts training center and small dams (Tyson 2000). Many local people are employed as park workers, and the aim of the program is to turn over management of this park and its biodiversity work to the Malagasy people. There needs to be a national park system with strict rules for management and protection, according to Patricia Wright, who deplored the illegal tree cutting by the previous park director at Ranomafana (Tyson 2000). She also has proposed that a national biodiversity institute be built, which would offer centralized training in biology and technology, as well as five new long-term biodiversity research stations similar to those in La Selva National Park in Costa Rica and the Smithsonian Institution's Panama tropical research laboratory (Tyson 2000).

Jobs, which are desperately needed by the Malagasy, are increasing as a result of the rise in the number of tourists. Selling crafts to tourists, running hotels and restaurants, and serving as guides are among these. Villagers who used to demand that parks be declassified so that they could legally gather wood, now request that more national parks be established, an apparent result of the new income that comes from fees and tourism (Morell 1999). International tourists have provided a major new source of revenue in Madagascar's economy and are helping the Malagasy see their wildlife in a new way, as so fascinating and biologically important that visitors come from every continent to view it. *Madagascar. The Bradt Travel Guide*, by Hilary Bradt (1999), published in various editions since 1988, is a useful aid for tourists, providing information about accommodations, natural history, protected areas, and the Malagasy and their history. Nature reserves and parks provide jobs by attracting scientists who employ local people, another incentive for the Malagasy to urge that more protected areas be set aside.

Compensation for lost access to forests has not been paid in the past, and new arrangements reached with villagers to allow some extraction of resources from the forests may heal some of these wounds and placate those who still wish to cut trees. Medicinal plants obtained from Madagascar may be another source of revenue in the future. The Rosy Periwinkle may be only one of many native plants highly valuable in treating disease. Research on the potential of other plants may uncover other such treasures. In the past, revenues from plants used for medicine have not been returned in part to the country of origin, but recently a new trend has begun. In one case, a pharmaceutical company agreed to pay people in a South American country a portion of the revenues gained from any native plant providing a

marketable drug.

Another potential source of revenue is the placement of videocameras connected to the Internet, which present websites with general information as well as live camera views of wildlife. South African parks have a number of these videocameras placed at water holes, animal dens and other key areas that capture live views of animals transmitted to the Internet for a small viewing fee. This has proven very successful, funding many of the South African National Parks system™s expenses. A similar system could be established in Madagascar with solar-powered videocameras, which have already been in use in Alaska, trained on tree canopies, rainforest flowers or lemurs, along with websites that provide basic information on Madagascar's environment, biodiversity and the Malagasy people. For millions of people who cannot visit Madagascar, such a website might be fascinating as a learning tool for teachers and the public, as well as an exciting view of these unique animals and their environments. If managed in such a way that profits were shared between poor Malagasy to alleviate their poverty, and conservation organizations to preserve biodiversity, such a system has great potential.

A satellite connection with classrooms in the United States or other countries would be another opportunity for interactive communication and learning. In December 2000, for example, students in an American classroom talked with students in a school in Guyana about endangered Giant Otters and their conservation through a visual satellite hookup. Students and others might set up an interactive link with biologists and conservationists working in Madagascar, asking questions and offering help. Students have provided many excellent ideas for conservation, and classes have raised money to save rainforests and threatened wildlife habitat and to help stop poaching of endangered species in countries half a world away from their own. Malagasy young people might be inspired and enthusiastic through talking with others of their own age about conservation and biodiversity. Video cameras and still cameras might be donated to Malagasy students and young people to record nature and compete for prizes with their results.

Madagascar™s Lessons

Madagascar's story is one of ecological catastrophe and the gradual extermination of its life forms. One's first response might be that its experience is as far from the rest of the world as it is geographically remote. However, it is from the extremes that one acquires basic knowledge. The effects of immigrants, whether human, animal, plant or disease, can devastate natural ecosystems wherever they occur. Islands are especially vulnerable to the effects of invasive species, including humans, because their flora and fauna have limited habitats and tend to be endemic, with small populations.

Exotic or non-indigenous species threaten 350 species of birds, or 30 percent of all threatened birds listed by BirdLife International in *Threatened Birds of the World* (BI 2000). Likewise, 361 plant species and 69 species of mammals listed by the *2000 IUCN Red List of Threatened Species* are threatened as a result of non-indigenous species (Hilton-Taylor 2000). The effects of invasive species, including humans, have been the major cause of extinction of virtually all bird species, almost all of which have occurred on islands. In the case of Madagascar, the Malagasy and other immigrant peoples and their livestock, and their subsequent hunting and habitat destruction, presented the vulnerable native species with threats against which they had no defense. Islands throughout the world continue to suffer losses in biodiversity, as do areas with large numbers of endemic species in mainland areas. Species with restricted ranges are the most likely to go extinct or become endangered. Such species dominate the list of birds in *Threatened Birds of the World* (BI 2000). In this age of international commerce, where plant diseases and other viruses are brought into countries in shiploads of lumber or ballast water, and exotic animals and plants continue to colonize and be released in delicate ecosystems with endemic species, whether on islands or mainlands, it has become extremely difficult to defend native species from such invasions. Nevertheless, through preserving native plants and animals and legislating against such introductions, while removing non-native species, ecosystems and their diversity can be protected. Preserving natural ecosystems is vitally important, not just for wildlife preservation, but for humans

as well, so that precious water supplies, topsoils and biological diversity, which stabilize all ecosystems, are protected. These lessons have not yet been put into practice in Madagascar or in many other parts of the world, including developed countries. Ecological and faunal changes may be so gradual that they go unnoticed until ecosystems have been destroyed.

Madagascar Testing Quotes

About 500 A.D., immigrant people from Asia, most probably Indonesia or Malaysia, arrived on Madagascar's shores in hand-hewn canoes, bringing domestic animals with them. They began clearing forests and burning them for farmland, and turned lakes and wetlands into rice paddies. Cleared land produced crops for only a few years until the thin soil became sterile. Farmers then moved on to other parts of the forest, in this slash-and-burn agriculture. At some point, African herdsmen colonized the island, bringing zebu cattle, which crowded out wildlife (Tyson 2000). Gradually, abuse of the land eroded the soil in the central highlands to bare earth, pocketed and gouged by deep gullies and cavernous holes. This region had harbored a great variety of lemurs, along with a wealth of birds, reptiles and unique plants. Throughout the island, wildlife declined as habitats disappeared, isolating animals in smaller and smaller patches of forest and wetlands. The large lemurs, tortoises and elephant birds were avidly hunted.

Within 600 years of the arrival of the Malagasy, extinctions claimed many native animals. Several elephant bird species, the larger lemurs and many native plants vanished. Two kinds of pygmy hippos inhabited the island. The Madagascar Hippopotamuses (*Hippopotamus lemerlei*), an amphibious species, and *Hippopotamus madagascariensis*, a forest species, were both about 6.5 feet long and 2.5 feet tall, smaller than the Common Hippopotamus of Africa, which is about 10 feet long (Tyson 2000). From genetic and anatomical analysis, both seem to have evolved from the latter species (Tyson 2000). The hippos had been widely distributed and very common prior to the arrival of the Malagasy (Dewar 1984). Their bones have been found with marks indicating that they had been butchered (Tyson 2000). Both died out long before Europeans arrived. The native crocodile, whose large bones have been found, is believed by some scientists to represent large specimens of Nile Crocodiles, the species native today (Tyson 2000). It is thus possible that the crocodile survived. A large mongoose-like viverrid, *Cryptoprocta spelea*, and a very unusual aardvark-like animal, *Plesiorycteropus madagascariensis*, died out at an early date (Dewar 1984).

Prior to the arrival of humans, elephant birds had been abundant in most parts of the island, as attested by the prevalence of their bones. There were two genera, and from six to 12 species of these birds (Tyson 2000). It is likely that the flightless birds fell prey to the primitive weapons of the Malagasy and were crowded out of their habitats by livestock (Tyson 2000). The last to die out was the Great Elephant Bird (*Aepyornis maximus*), which may have survived until recent times by retreating to remote swamps. Dr. Alexander Wetmore of the Smithsonian Institution examined bones of a Great Elephant Bird unearthed in archeological excavations in the 1960s. He was amazed by their size: "The incredible femur, or thighbone, of this ponderous bird is by far the largest I have ever seen" (Wetmore 1967). Estimated to weigh at least 1,000 pounds, more than three times the weight of an Ostrich, it produced eggs larger than any dinosaur's, with a capacity of 2 gallons (equivalent to seven Ostrich eggs), 180 chicken eggs or 12,000 hummingbird eggs (Bradbury 1919, Fuller 1987). When one was X•rayed, the bones of an embryo three•fourths developed were revealed (Wetmore 1967). Something had interrupted the embryo's growth and frozen it within the eggshell for hundreds and perhaps thousands of years (Wetmore 1967).

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that the Great Elephant Bird was still found in the south of the island, "seeking the most deserted places" to avoid human hunters (Tyson 2000). Villagers of Antandroy told of an Ostrich-like bird that was difficult to catch, according to Flacourt (Tyson 2000).

The exact date this giant bird became extinct is not known with certainty. Alan Feduccia (1996), an eminent paleo-ornithologist, asserts that elephant birds of many species were still widespread in the 10th century but gradually disappeared as a result of human activity. He cites an account by a French merchant sailor in 1848, who visited Madagascar and saw the shell of the Great Elephant Bird; he was told that it belonged to the chief and that the bird that produced such eggs "is still more rarely seen" (Feduccia 1996). Some authorities estimate that it died out in the mid-17th century, although there is no proof that any European ever saw one of these birds (Tyson 2000). It has been suggested that Europeans were responsible for the bird™s extinction by hunting and destroying its habitat (Quammen 1996). But Thomas Brooks (2000) of the Center for Applied Biodiversity Science, Conservation International, asserted in a list of extinct birds in *Threatened Birds of the World* (BI 2000) that all the elephant birds had disappeared by 1500. In a bizarre footnote to this species' epitaph, an *Aepyornis* egg washed up on Australia's western coast in 1995. No conclusive explanation for this strange event has been put forth, although it is likely that it became unearthed from long interment by rains, and washed out to sea. Much less is known of the other species of elephant birds, which existed in a variety of sizes down to a chicken-sized species.

Lemur-like primates once lived on many continents, but nowhere had they evolved into such a great variety of species. When the Malagasy people arrived some 1,500 years ago, lemurs occupied every habitat, even marshland. A species as tall as a man must have startled the Malagasy immigrants, giving rise to legends that these animals had superhuman powers. The first French naturalists were told by the Malagasy that these primates were thought to be the ghosts of sacred ancestors of man, inspiring the genus name Lemur, the word for ghost in Latin. The Malagasy considered some lemurs sacred and punished anyone who harmed them, but most species were feared as evil demons and were killed on sight.

From their arrival on Madagascar, the Malagasy hunted the larger species of lemurs, almost all of which are now extinct. Archaeological excavations show that they formed a staple in the immigrants' diets. Such diggings have unearthed the skulls and bones of long•extinct lemurs in early Malagasy jars and kitchen middens; their heads had been split by ax-heads made from an extinct flightless bird (Jolly 1980).

In the centuries following colonization by the Malagasy immigrants, some 15 species of lemurs of eight genera became extinct (Mittermeier 1997). These extinct lemurs were, for the most part, far larger than surviving species and had evolved to fill many ecological niches. Three *Megaladapis* lemurs weighed between 90 and 170 pounds and moved slowly through the trees, feeding on foliage (Tattersall 1993). Another species, *Archaeolemur*, was about the size of a female baboon and lived on the ground (Tattersall 1993). Two *Palaeopropithecus* species weighed between 90 and 130 pounds and were sloth•like tree dwellers with flexible bodies (Tattersall 1993). These extinct lemurs had evolved many unusual means of movement and locomotion that have no parallels in living species of lemurs.

Largest of all, the massive 400•pound *Archaeoindris* was apparently a ground•dweller, moving on all fours; many of its anatomical characteristics are unlike any living primate (Tattersall 1993). One entire lemur family, Archaeolemuridae, was obliterated. In this family were many species of lemurs weighing between 35 and 55 pounds; they were powerfully built and short•legged (Tattersall 1993). The heaviest lemur surviving today, the Indri (*Indri indri*), weighs only about 15 pounds (Tattersall 1993). These lemurs had survived for millions of years, and their extinctions were indeed a major biological loss to the planet. According to primatologists, the surviving lemurs resemble the very earliest primates from the Eocene (Tattersall 1993). Like prosimians in Africa and Asia, but to a far greater degree, lemurs have a highly developed sense of smell. Some species have long, fox-like noses (Preston-Mafham 1991). Genetic analysis of their DNA has revealed that all lemurs are descended from a single ancestor that probably arrived from Africa about 60 million years ago (Garbutt 1999).

The Giant Aye-aye (*Daubentonia robusta*) lemur was somewhat larger and 2.5 to 5 times heavier than the surviving

Aye-aye (see below), but in other respects was very similar (Garbutt 1999). It is known from subfossil remains found in southwestern Madagascar (Nowak 1999). The date of its disappearance is unknown but may be fairly recent.

Archaeologists have uncovered remains of a massive bird of prey, the Malagasy Crowned Eagle (*Stephanoaetus mahery*), which undoubtedly preyed on lemurs (Feduccia 1996). In fact, at one locality the diet of this eagle, based on the bones of eagles and lemurs found together, contained at least 80 percent primates, including specimens weighing up to 26.5 pounds (Feduccia 1996). Remains of another large eagle of the genus *Aquila* have been discovered, and it, too, preyed on large lemurs and became extinct after the arrival of the Malagasy. These extinct birds preyed on smaller lemurs as well, including some species still surviving (Feduccia 1996). A bird of prey flying overhead still elicits fear in lemurs, causing them to seek cover. Neither of the two remaining species of eagles on Madagascar preys on lemurs, but two hawk species have been seen preying on young lemurs (Garbutt 1999).

In addition to the Giant Elephant Bird, the large Snail-eating Coua (*Coua delalandei*), a member of the cuckoo family, became extinct. The last specimen of this large, slate-blue bird was taken on an islet off the east coast, Ile Sainte-Marie, in 1834 (Morris and Hawkins 1998); reports by observers who claimed to have seen the bird were recorded as late as 1930 (Fuller 1987). The causes of this bird's disappearance, and even its exact range, remain obscure (Langrand 1990). Many specimens of this bird were taken before its extinction and kept in museums in Leiden; London; New York; Paris; Philadelphia; Tananarive (Madagascar); and Cambridge (Massachusetts) (Fuller 1987). The long feathers of this bird were highly valued by the Malagasy, and hunting may have reduced its numbers to a critically low level (Fuller 1987). It is also possible that the many birds killed for zoological specimens may have pushed this already rare bird to extinction, since its distribution may have been limited to the tiny Ile Sainte-Marie. No reliable record exists of its presence on the main island of Madagascar, but there is hope that it might be found in lowland forest near the Bay of Antongil (Morris and Hawkins 1998). Ten closely related species of couas survive, all smaller than the Snail-eating Coua.

Madagascar Testing Quotes 2
Testing "quotes again" to see whether they are "going" to have 'slashes' added to them or not.

Madagascar and other Islands

http://www.endangeredspecieshandbook.org/madagascar_human.php

Madagascar

Imagine an island more than 1,000 miles long in a blue tropical ocean. Forests cover vast areas, interspersed with swamps where crocodiles 8 meters long lie in wait to prey on pygmy hippopotamuses. Thousands of giant tortoises with shells 4 feet across lumber about. In the forests and in dryer parts of the island live some of the strangest primates to have ever existed on Earth. Some 45 species of these lemurs live throughout the island and range in size from the world's smallest primate, weighing about 1 ounce, to a lemur the size of a Gorilla (Tattersall 1993).

Huge white birds plod along forest trails and through savannah grasses. Many kinds of these birds inhabit the island. The largest resembles an Ostrich, but is far more massive in build, weighing 1,000 pounds (Feduccia 1996). It stands 10 feet tall and lays 20-pound eggs, 13 inches long (Feduccia 1996, Greenway 1967). More than 100 other kinds of tropical birds that exist nowhere else fly in forests and deserts and wade in still marshes.

Primitive hedgehog-like mammals, called tenrecs, scurry in forest underbrush. One type of tenrec lives in cold mountain streams, swimming with webbed feet and flattened tail, while another has spines like a porcupine and stripes down its back like a skunk. It communicates with its young by vibrating its spines.

Hundreds of kinds of amphibians and reptiles inhabit forests, aquatic environments, savannahs and drylands. Frogs of every imaginable color and pattern leap in green shadows. Chameleons, some brilliantly colored, and others shades of mottled brown, creep invisibly about. The largest, 2 feet long, can capture mice and birds, while the smallest, measuring only 1.5 inches, feeds on insects (Amos 1980). Tortoises with shells adorned in delicate yellow sunburst patterns inhabit shrub and deserts.

Plants exist in unparalleled variety, a botanical paradise. Relicts of species long-extinct on mainland areas--tall tree ferns, palms, red-flowered flame trees, massive deciduous and rainforest trees, giant tamarinds and aloes, desert oddities, and baobabs of many sizes--grow in even the driest parts of the island. Orchids in a rainbow of colors bloom among the deep green rainforests. Waterfalls abound, cascading down tall cliffs into rivers and lakes. Along the west coast, a dry deciduous forest stretches the length of the island**.** The central highlands are a mosaic of woodland and savannah, while the eastern regions are covered in dense, humid rainforest. In the extreme south, a desert environment prevails, harboring *Didierea*, strange cactus-resembling plants that form long, spiny, twisted shafts rising 30 feet into the air. An impenetrable wilderness of limestone spikes and sharp rocks dominates the far north. Rare birds and lemurs find refuge in this craggy landscape and feed in oases watered by meandering streams.

Flightlessness, fearlessness, gigantism, dwarfism, and survival of ancient species all occurred in this evolutionary laboratory. That such a large land mass went uninhabited by humans for so long is truly remarkable. Nowhere else on the planet has such a large land area remained isolated for such a prolonged period, allowing a flowering of diverse life forms to flourish and adapt to the island's many habitats and terrains in this mild, tropical climate. Such is the history of the island from Madagascar in 400 A.D., a century before the arrival of the Malagasy people of Asia. Had humans reached Madagascar earlier, it might not have evolved its diverse, yet vulnerable, fauna and flora.

How such an extraordinary diversity of animals and plants inhabits Madagascar is tied to its geological history. Some 160 million years ago, when Africa, Australia, New Zealand and South America were united in the super-continent Gondwana, Madagascar was attached to eastern Africa and what is now peninsular India. Dinosaurs, giant turtles, crocodiles, primitive mammals, reptilian birds and lizards roamed on this massive land mass. Gondwana gradually broke apart as a result of movements of tectonic plates covering the Earth's crust. For many millions of years, India and Madagascar formed a mini-continent. Then, about 88 million years ago, they split along Madagascar's east coast, and peninsular India moved northward toward Asia (Garbutt 1999, Tyson 2000). Paleontologists have only recently discovered that Madagascar was home to dinosaurs and other primitive animals quite unlike those found in other parts of the world. The oldest known species of dinosaur, dating back 227 million years, may be the ancestor of all dinosaurs (Flynn 2000). One dinosaur had teeth that were clove-shaped (Stenzelt and Thiessen 2000). Seven species of crocodiles inhabited Madagascar from the Cretaceous period onward, including a pug-nosed vegetarian species (Flynn 2000). About 65 million years ago, the last dinosaurs died out, concurrent with their extinction throughout the world. Some native plants and animals survived from the time when Madagascar was part of Gondwana. Giant tortoises, crocodiles, boas, tenrec ancestors and possibly an early form of elephant birds may have lived on the super-continent, although most ornithologists are certain that the ancestor of the elephant bird flew to the island and became flightless (Feduccia 1996). Plants of many kinds, virtually unchanged from their ancient forms, grow on the island.

Immigrant animals arrived during the millennia from many sources. Because Madagascar separated from India and Gondwana long before the evolution of the prosimians that were the ancestors of the lemurs, these primates must have come from mainland Africa, where their close relatives, bush babies and galagos, survive today. Some scientists believe they might have traveled over a land connection that existed between Africa and Madagascar at some point (Tyson 2000). Others dispute that there ever was such a land bridge and maintain that they arrived by sea, perhaps sheltering on large mats of floating vegetation or clinging to uprooted tree trunks that swept down mainland rivers to the sea and washed up on Madagascar's shores. Few modern mammals of Africa, whether baboons, monkeys, gazelles, antelope or other hoofed mammals, reached Madagascar. The hippopotamuses must have originated in Africa, but how they came to the island is another mystery.

Over many millennia, a blossoming of evolution occurred in this mild, tropical climate of Gondwandan and immigrant species, radiating into entire new families and creating a flora and fauna of great diversity unlike any in the world. Birds, bats and insects flew or were blown to the island by wind currents and storms from Africa and Asia. No large carnivores arrived, however. The largest mammal predators are relatives of mongooses, primitive viverrids. Grazing and browsing roles were filled by hippopotamuses, land tortoises, lemurs and elephant birds.

Human Settlers Invade Paradise

About 500 A.D., immigrant people from Asia, most probably Indonesia or Malaysia, arrived on Madagascar's shores in hand-hewn canoes, bringing domestic animals with them. They began clearing forests and burning them for farmland, and turned lakes and wetlands into rice paddies. Cleared land produced crops for only a few years until the thin soil became sterile. Farmers then moved on to other parts of the forest, in this slash-and-burn agriculture. At some point, African herdsmen colonized the island, bringing zebu cattle, which crowded out wildlife (Tyson 2000). Gradually, abuse of the land eroded the soil in the central highlands to bare earth, pocketed and gouged by deep gullies and cavernous holes. This region had harbored a great variety of lemurs, along with a wealth of birds, reptiles and unique plants. Throughout the island, wildlife declined as habitats disappeared, isolating animals in smaller and smaller patches of forest and wetlands. The large lemurs, tortoises and elephant birds were avidly hunted.

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The Biological Wealth of an Impoverished Country

The Madagascar of today is still a remarkable place, although about 90 percent of the forests, including almost all lowland rainforests that were richest in wildlife, were destroyed (Mittermeier *et al.* 1999). Some 33 lemur species survive, along with all but one species of tenrec, various mongooses and their relatives, more chameleons than any other country, several hundred kinds of frogs and reptiles, and thousands of endemic invertebrates and plants. Madagascar has no native fish, but many introduced species. Its fauna and flora represent many extremely unusual and unique examples of evolution (Mittermeier *et al.* 1999). This island is considered one of the five most biologically important areas in the world; its primates are the world's highest priority for conservation (Mittermeier *et al.* 1999).

The Biological Wealth of an Impoverished Country: Forests and Plants

Madagascar has one of the richest floras in the world. Eighty percent of its plants are found nowhere else (McNeely *et al.* 1990, Preston-Mafham 1991). The diversity of plants that survived almost 2,000 years of forest destruction continues to astound biologists and conservationists. Tropical trees with fruit growing on their trunks (various species of the genus *Tambourissa*) are native, as is a cactus (*Rhipsalis*), related to American species, that lives in the rainforest. A tree, *Symphonia*, which has leathery leaves and red-and-white striped flowers that look like peppermint candies (Morell 1999), also survives. The Flame Tree (*Delonix regia*), which produces cascades of red flowers, is grown around the world for its beauty, but few realize that it originated in Madagascar (Preston-Mafham 1991). Miraculously, many endemic plants have survived the fires and tree cutting that have destroyed much of the island. One mountain chain has 150 endemic vascular plants, a very high number (Preston-Mafham 1991). They are among the 7,300 to 12,000 species of plants native to Madagascar (Preston-Mafham 1991). Its flowering plants make up 20 percent of all the plants in the African region (McNeely 1990). At least 191 botanical families, a very large number for a relatively small area, evolved from ancestor species (Preston-Mafham 1991).

Some 2,000 years ago, the eastern rainforest stretched in a band 100 miles wide from north to south, covering 27 million acres (Tyson 2000). Ninety percent of the plants were endemic, with a profusion of unusual ferns, some types growing on tree trunks; wild ginger, with delicate purple flowers; bamboos; and far more orchids than in an African rainforest (Preston-Mafham 1991). An early traveler described the woods as so dense that there was a fideep gloom: below the canopy at mid-day (Tyson 2000). Rainfall must have been greater and general climate more humid than at present as a result of these extensive rainforests. In the montane ridges, huge tree ferns, mosses and lichens cover the ground and hang from tree branches (Preston-Mafham 1991). Over the centuries, Malagasy burned many portions of the rainforest, especially in the south. Few tall trees remain in the rainforest today, although at one time there must have been many giants. During the 19th century, a palace was built for a woman ruler, centering on a 130-foot tree that had been carried by 5,000 laborers from the eastern rainforest (Tyson 2000). The palace was destroyed by an uprising in the 1850s. About this time, Malagasy dragged a tombstone through the forest, cutting 25,000 trees just to make a path (Tyson 2000). Early decrees banned cutting of virgin forest, with severe penalties, in the 19th century, but these were largely ignored (Tyson 2000).

About half of the island's forests had been cut by the late 19th century, and intensive cutting continued in the 20th century (Tyson 2000). The prime lowland forests throughout the island and three-fourths of the rainforest were cleared by the French for growing coffee and other crops in the first three decades of the century (Tyson 2000). The rainforest was heavily logged between 1950 and 1985, with 275,000 acres cleared and burned each year (Tyson 2000). The northeast Masoala Peninsula still retains sizeable areas of unlogged rainforest, but the southern region has been reduced to fragments of the original unbroken expanses. The remnants tend to be on sharp ridges where soil is poor and access difficult. For example, Ranomafana, a recently declared national park, straddles such an escarpment. Even so, many of its trees had been removed prior to its protection (Tyson 2000). What was once a closed-canopy, humid rainforest is now far dryer and cooler, with many openings among the trees, and some illegal logging continues (Tyson 2000). Still, botanists from the Missouri Botanical Garden, who were conducting a census of the trees in this park, counted 37 families of trees with 105 species in a 1-hectare plot (Tyson 2000). Outside the park's boundaries, rainforest is still being cleared and burned by the Malagasy, many of whom believe that their wealth lies in the amount of land they clear (Morell 1999).

The western dry, deciduous forest lies in the shadow of eastern mountains, which block moist ocean air currents (Preston-Mafham 1991). Trees do not attain heights of more than 80 feet, but many types of plants have adapted to this environment. Liana vines grow among the trees, and dead leaves carpet the forest floor. Large tamarind trees grow along rivers, and baobabs grow in plateaus (Preston-Mafham 1991). Beautiful orange bell flowers of the *Ipomoea carnea* plant burst into bloom during the short rainy season. As with the eastern rainforests, the once continuous stretches of deciduous forests have been largely destroyed, replaced by grasses able to survive in the eroded or bare soil.

Throughout the island, most deforested areas fail to regenerate into second-growth forests, even when left fallow,

because Madagascar lacks vigorous colonizing trees that can quickly protect cleared ground and prevent further erosion (Preston-Mafham 2000). Cleared hillsides become covered in non-native grasses and exotic South American trees (*Psidium cattleyanum* and *Psidium guajava*) or plantations of eucalyptus, which inhibit the establishment of native seedlings (Preston-Mafham 1991; Sayer *et al.* 1992). Only if soils are rich and remnants of original forest are nearby will native forests regenerate. Unfortunately, the original forests and their native wildlife are lost permanently, and even regeneration cannot take place without a cessation of the slash-and-burn cycle, known as fitavyfl by the Malagasy (Preston-Mafham 1991). Moreover, foreign logging companies have obtained logging concessions on most of the unprotected remnants of native forest. Tree cutting consumes some 7.8 million cubic meters of wood per year, of which 7 million cubic meters is for fuel and charcoal (Sayer *et al.* 1992). Valuable timber trees have been logged to extinction in most of Madagascar. The two native species of ebony trees of the genus *Diospyros* have been heavily logged for centuries, and few large trees are left (Sayer *et al.* 1992). The understory plants, such as tree ferns, are also exploited, dug up to sell as potted plants (Sayer *et al.* 1992).

The net result of this logging and burning, especially in the barren central highlands, is the loss of "a priceless reservoir of plant and animal species, replaced by one of the most impoverished forms of vegetation on the planet" (Preston-Mafham 1991). Many species of trees and other plants are highly endangered. Madagascar is one of the world's 12 "hot spot" areas of tropical forests, having a high percentage of endemic species which are under great threat (McNeely *et al.* 1990). Since an estimated 94 percent of Madagascar's trees are endemic, and many occupy very restricted ranges, they are highly vulnerable to extinction. Further research will likely reveal even more threatened species. Some authorities believe that even this rich plant diversity must represent only a fraction of the "vast original flora," since 80 percent of the vegetation and forests is gone (Ayensu *et al.* 1984). The *1997 IUCN Red List of Threatened Plants* includes 19 species of plants that may have recently become extinct, and an additional 287 species that are threatened with extinction (Walter and Gillett 1998).

Resident since the days of the dinosaurs, trees of a family of primitive pines, Podocarpaceae, grow on the island. The family is represented by species in other parts of the world that were part of Gondwana, from South America west to Southeast Asia. Madagascar has a number of native Podocarps, of which four endemic species or varieties are listed by the *IUCN Red List* as either Vulnerable or Rare (Walter and Gillett 1998). At least 26 genera of plants are native to Madagascar and South America, but not to Africa, and are believed to be remnants from Gondwana (Preston-Mafham 1991). Another one of these, Madagascar's national tree, the Traveller's Tree (*Ravenala madagascariensis*), is a palm-like species of the banana family (Musaceae). Its closest relative of the same genus grows in Brazil and Guiana, but not in Africa (Preston-Mafham 1991). This tree has leathery petals covering its pollen and nectar and is a key food source for both bats and lemurs. In return, it depends on lemurs for pollination. Lemurs feed on the nectar, getting their noses covered with pollen in the process. They are so fond of the nectar that they travel miles to find another Traveller's Tree, still carrying the nectar on their noses and, unknowingly, pollinate the next tree they feed on (Attenborough 1995).

A plant of the Winteraceae family that has been growing on the island for 30 million years was recently seen again after a period of 90 years (Hsu 1997). This tree, *Takhtajania perrieri*, has many primitive features, such as a lack of vessels to move water and minerals; like many of Madagascar's relict species, it once grew on much of continental Africa, but long ago disappeared there (Hsu 1997).

Madagascar has more palms (Palmae family) than all of Africa (Preston-Mafham 1991). Many are in danger, however. The *IUCN Red List of Threatened Plants* lists 148 native species in various categories (Walter and Gillett 1998). The Big-leaf Palm (*Marojeya darianii*) was chosen by the Species Survival Committee of the IUCN to be one of 12 critically endangered species highlighted at its 1988 General Assembly in Costa Rica. This species was only discovered in 1982 and is confined to a single swamp in the northeast (Prance 1990). An agricultural program to raise rice cleared half its habitat, and then failed. This huge-leafed palm has been over-harvested as a source of heart-of-palm, a commercially valuable product (Prance 1990). Huge palms are felled for their inner pith to supply this gourmet market. The majority of palms grow in the eastern rainforests in a great diversity of size. Two threatened palms, *Dypsis hildebrandtii* and *Dypsis louvelii*, are miniature delicate-fronded palms only 3 feet high

(Preston-Mafham 1991). Others, like the threatened *Ravenea glauca*, are majestic giants with long, straight trunks rising 50 feet or more to a luxuriant crown. Palms do not often survive the fires set by the Malagasy to clear land, disappearing from one area after another (Preston-Mafham 1991).

On the entire continent of Africa, only one species of baobab tree is native, while seven species are found in Madagascar (Preston-Mafham 1991). These strange-looking trees have wide trunks that taper to a narrow crown, looking like upside-down trees. Some baobabs grow to immense size. One famous specimen measures 46 feet around the base of the trunk (Preston-Mafham 1991). Another species, *Alluaudia ascendens*, grows in the southern desert. Although it can reach a maximum height of 16 feet, it is usually far smaller (Preston-Mafham 1991). Each of the seven species has a slightly different shape and size, but all have gray bark that resembles unwrinkled elephant skin. Baobabs are extremely important to both wildlife and humans. The Malagasy cut holes in their massive trunks and hollow out the spongy pith where water accumulates. In the dry south, these trees become wells, and villagers set ladders against the trunks, climb to the hole cut from the trunk, and lower buckets into the pool of water. Natural holes in baobob trunks and branches provide important nesting holes for birds and lemurs. These trees are fire-resistant, and fortunately, they are worthless as timber because of their soft, pulpy cores. For this reason some stands of thousands of huge, very old baobabs remain in parts of the island. Because of the heavy livestock grazing, few young baobab seedlings can survive, however, and botanists believe that the spectacular vistas of these behemoths will gradually disappear (Preston-Mafham 1991).

One very strange group of Madagascan plants native to dry areas has nine species in the same genus, *Pachypodium*. These succulent plants lose their leaves at the onset of the dry season and have evolved into a variety of forms, all with gray, smooth bark. Eight of the nine species are threatened with extinction, according to the *IUCN Red List of Threatened Plants* (Walter and Gillett 1998). One of these, the endangered *Pachypodium decaryi*, is native to Antananarivo, the "tsingy" limestone crags of the northwest. Its smooth, silvery trunk resembles a large inverted turnip, fat at the base and tapering upward, topped by a messy mop of thin, straggly branches (Preston-Mafham 1991). It bears large, white flowers during the dry season. Its main population occurs in the Ankarana Special Reserve, which bans burning (Preston-Mafham 1991), but has recently been invaded by hordes of miners who are clearing vegetation to search for sapphires (Morell 1999). Other Pachypodiums have equally bizarre shapes, such as the bulbous *Pachypodium rosulatum*, which resembles a huge gourd sprouting long, thin shafts from which its bright yellow flower bloom. The rare *Pachypodium densiflorum*, with the appearance of a domestic jade plant run amok, has a mass of short, gray branches sprouting from a squat gray base. All these plants are highly susceptible to fire. Ken Preston-Mafham, in *Madagascar: A Natural History*, describes the threat of "incessant brush fires which ravage the length and breadth of central Madagascar during the dry season. Within hours, hillsides which had been decorated with colorful rock gardens of rare succulents are converted into graveyards of charred embers." These brush fires have been intentionally set by Malagasy to improve grazing land for their cattle or clear land. Another threat to Pachypodia is collectors who tear specimens, especially bizarre forms, from mountain slopes (Preston-Mafham 1991). Few species are protected in reserves. Without strong conservation programs, these fascinating plants could easily disappear.

Other strange trees of the southern spiny desert include the Octopus Tree (*Didierea madagascariensis*), a member of an endemic family of 11 cactus-like species, Didiereaceae. This tree has no trunk, but a bouquet-like grouping of stems covered in long, needle-sharp spines that branch out in odd, twisted shapes. Although resembling cacti, this family has no close relatives anywhere in the world (Preston-Mafham 1991). Another member of the family, *Alluaudia procera*, has a thick trunk with very long spines that grow in curving rows upward, and small, rounded leaves along its branches. In spite of this, several lemur species are able to leap onto these plants without hurting themselves (Preston-Mafham 1991). Three species in this family, all of the *Alluaudia* genus, are Rare, according to the IUCN (Walter and Gillett 1998). One of these, *Alluaudia montagnacii*, has tall, solitary tapering stems ending in a tuft of flowers.

The discovery of the medicinal effects of the endemic Rosy Periwinkle (*Catharanthus roseus*) has saved thousands of human lives. Two potent alkaloid compounds found in this plant have proven effective in the treatment of

Hodgkin™s' Disease, producing a 99 percent remission in patients with acute lymphocytic leukemia (Myers 1983). It also contains 75 different alkaloids, which could produce commercial substances (Preston-Mafham 1991). Fortunately, the Rosy Periwinkle is easy to propagate, grown in greenhouses around the world. Ongoing research is uncovering other Madagascan plants of medicinal value. Samples of plants are being tested in laboratories, and elderly Malagasy healers are being consulted. More than 50 species of wild coffee (*Coffea* spp.) grow in the island's eastern rainforests, providing an important genetic base for hybridizing with other strains because of their insect-resistance and low level of caffeine (Preston-Mafham 1991). These plants are symbolic of the great botanical wealth at risk.

The Biological Wealth of an Impoverished Country: Mammals

Home to some of the world's most fascinating, beautiful and curious mammals, Madagascar has approximately 117 native species, 90 percent of which exist nowhere else (Garbutt 1999). Excluding bats, all 88 native terrestrial mammals are endemic to Madagascar. Three-fourths of native mammals, or 66 species, are threatened with extinction; 49 of these are in higher categories of threat listed in the *2000 IUCN Red List of Threatened Species*. This represents 42 percent of all mammals found in Madagascar, by far the greatest percentage of threatened mammals of any country in the world (Hilton-Taylor 2000). As new species of mammals continue to be discovered, the numbers that are threatened continues to rise. A few have not been seen in the wild since their discovery. The majority is made of forest-dwellers, and a few inhabit marshy areas or woodland streams. The loss of forest, predation on them by Malagasy and domestic dogs, and introduction of exotic species of mammals that out-compete native species are combining to push many of the island's mammals toward extinction.

Page 1 (Tenrecs)
Page 2 (Lemurs and Aye-ayes)
Page 3 (Bats)
Page 4 (Viverrids)
Page 5 (Rodents)

The Biological Wealth of an Impoverished Country: Mammals: Page 1

The publication of *Mammals of Madagascar*, by Nick Garbutt, in 1999 filled a void for a complete guide to all native mammals, illustrated with color photos of most species and major habitats. This supplemented *Madascar: A Natural History* in 1991, an important reference on mammals and their environment. Conservation work has focused mainly on lemurs, with many organizations involved, including Earthwatch Institute, which sponsors field research; Conservation International; Jersey Wildlife Preservation Trust (based in England); and CARE. Several of these groups sponsored biodiversity studies and helped establish national parks, benefiting thousands of species, including tenrecs and other native mammals. A growing number of Malagasy zoologists are taking part in studies and conservation work, and new programs have been initiated to help local people while conserving mammals and their environments. Certain mammals have received inadequate attention to date, notably bats, rodents and some viverrids, who will undoubtedly benefit from the swell of interest and enthusiasm for Madagascar fauna that has developed in recent years. Filmmakers have recently produced a number of excellent wildlife documentaries, photographing rare species and spreading knowledge and concern about endangered mammals (see Video section).

Among Madagascar's mammals are many primitive forms. The tenrecs' closest relatives are insectivores known as solenodons, native to Cuba, Hispaniola and other vestiges of Gondwana in the Caribbean. Tenrecs and solenodons may have had a common ancestor living on the supercontinent, progenitor of all mammals. The remains of similar

species have been found in Africa and South America, indicating that they were once very widespread but died out on all but isolated refuges such as Madagascar and West Indian islands. Tenrecs belong to a family of insectivores, Tenrecidae, related to shrews, moles and hedgehogs, but quite distinct from them. Twenty-seven species of three types of tenrecs make up this family--spiny, furred and otter-shrews (Garbutt 1999). They range in size from the Common Tenrec (*Tenrec ecaudatus*), which resembles the European Hedgehog and weighs more than 5 pounds, to the shrew-like tenrecs, *Microgale* genus, weighing less than 2 ounces (Nowak 1999). Tenrecs have some very unusual physical characteristics placing them far from any close mammalian relative. They have variable body temperatures that change with the ambient temperature and, an even more reptilian or avian trait, a cloaca that combines urinal, rectal and generative canals into one (Garbutt 1999).

A striking tenrec is the Lowland Streaked Tenrec (*Hemicentetes semispinosus*). It and a similar species, the Highland Streaked Tenrec (*Hemicentetes nigriceps*), weigh about 5 to 7 ounces and measure some 6 inches in length. White stripes run down their backs like skunks, and barbed, porcupine-like spines are detachable (Eisenberg 1975). The Highland species has a stiff, white neck ruff rising several inches at the back of its head that can be stabbed into the nose of an unwary predator (Eisenberg 1975). Family groups forage together and communicate by vibrating quills that produce low-frequency sounds like dry grass being rubbed together; tenrecs can detect these sounds from distances of more than 4 meters (Garbutt 1999). They also make a number of sounds that are audible to humans.

The Aquatic Tenrec (*Limnogale mergulus*), listed as Endangered in the *2000 IUCN Red List of Threatened Species*, inhabits streams and lakes, living at altitudes between 600 and 2,000 meters (Nowak 1999). This 8-inch tenrec has clawed, webbed feet, and a long, thin tail for propelling it through the water to feed on small crustaceans and fish. Its habitat in the central highlands has been greatly affected by human disturbance and deforestation. The Aquatic Tenrec has at least one refuge, the new Ranomafana National Park, created for the bamboo lemurs (Preston-Mafham 1991). In 1990, Dr. David Stone managed to lure an Aquatic Tenrec into a live trap, the first one of its kind seen alive in 25 years (Preston-Mafham 1991). Later, four more were taken and studied in captivity for three weeks prior to being returned to the river Namorona in Ranomafana, one of the few clear, unsilted rivers left in Madagascar (Preston-Mafham 1991). This species requires such streams, and only the preservation of forests, such as that in Ranomafana, will ensure its survival.

Another six species in this family, all shrew-tenrecs of the genus *Microgale*, are listed in the *2000 IUCN Red List of Threatened Species*. These tiny insectivores are found in all parts of Madagascar in areas of heavy vegetation, and have dark, soft fur. They range in size from 1.5 to 5 inches in length, and weigh as little as 1.8 ounces (Nowak 1999). Several of the threatened species are highly restricted in range and habitat, and one, *Microgale dryas*, listed as Critical, occurs only in Ambatovaky Special Reserve in the northeastern rainforest (Garbutt 1999).

The Biological Wealth of an Impoverished Country: Mammals: Page 2

Far better known to the world, the lemurs are the focus of many programs to conserve them, as well as research on their wild behavior and biology. New species continue to be discovered; most recently in 2000, three new species of tiny mouse lemurs. Three more have been rediscovered, an indication that other species may yet be discovered to add to the present total of 33 species (Garbutt 1999)**.** This is the only country with five families of primates, making up more than one-third of all primate families; it is home to 12 percent of all primate species and 21 percent of all primate genera (Mittermeier *et al.* 1999). Unlike Brazil, however, which is another center for endemic mammals, Madagascar is far smaller, the size of Kenya, covering 226,656 square miles, or 0.4 percent of Earth's surface (NYT 2000). The number of lemur species is not an indication of their variety since many subspecies differ so radically from one another that in the future, each may be accorded full species status. One species of sifaka, a long-legged kind of lemur, has one subspecies that is pitch black, and another that is pure white. At least 51 species and subspecies of lemurs are known to exist (Mittermeier *et al.* 1999).

The most gregarious of the lemurs are the Ring•tailed Lemurs (*Lemur catta*), who travel about in boisterous, friendly troops, living mainly on the ground. These lemurs have long, fox-like muzzles, large, soft golden-brown eyes, fluffy, gray fur, and black-and-white striped tails. Their body length is 15 to 17 inches, but their rope-like tails are half-again as long, from 21 to 24 inches (Nowak 1999). These 5-pound primates use their boldly patterned tails in a complex language of mutual visual and scent signals. They wave them about to show dominance, as a signal to follow other group members, or rub them on their wrist glands to wave at their rivals in territorial battles (Sleeper 1997). Moving about in troops of up to 25 individuals, they walk rapidly on the ground with the tail held high, waving it about. They wrap their tails around themselves for warmth on chilly nights. Extremely affectionate and playful, their core group is dominated by females (Jolly 1988).

In reserves where they are strictly protected, Ring-tailed Lemurs become very tame, napping on the ground in piles of leaves near tourists. Sometimes they sprawl out on their backs with arms spread wide apart. Females usually have a single young, but when twins are born, one may be "adopted" by a non-pregnant female, who may begin to produce milk in response to her surrogate role (Preston-Mafham 1991). Aunts also help in raising the young, and the daughter born the previous year babysits (Jolly 1988). Lemur babies are a source of great interest to the entire troop, females gathering around the mother and her young, grooming one another and the babies, forming a "grooming pod" (Preston-Mafham 1991). Only half of the infants survive their first year, and only 30 percent reach adulthood (Garbutt 1999). "A Lemur's Tale," shown on PBS in 1996, is a touching film about the death of a young Ring-tailed Lemur. Some fall from high branches, are killed by small carnivores or hawks, die of undiagnosed illness or starve in years of drought in their arid habitat. Ring-tailed Lemurs communicate with one another in a variety of sounds, from soft mewing contact calls to a territorial "bark-howl." Sometimes chasing and cuffing other members of their group, they are mainly peaceful, spending many hours a day in mutual grooming and in "snoozing-huddles," in which several animals form a complicated embrace from which tails and feet stick out in all directions (Preston-Mafham 1991).

In recent years, Ring•tailed Lemurs have been classified "high priority" for conservation by the IUCN and the Species Survival Commission (SSC) Primate Specialist Group because their habitat of dry woodlands in southern Madagascar is disappearing at an alarming rate due to fires, overgrazing by livestock and tree cutting; they are also hunted with dogs in some areas, and captured as pets (Mittermeier *et al.* 1992, Garbutt 1999). Their distribution has become increasingly patchy as forests are cut (Garbutt 1999). The *2000 IUCN Red List of Threatened Species* lists the Ring-tailed Lemur as Vulnerable, or declining toward endangered status.

One of the strangest mammals in the world is the Aye•aye (*Daubentonia madagascariensis*), so unique that it is assigned to its own family, Daubentoniidae. When first discovered, scientists classified it as a squirrel because of its long, bushy tail and short•legged body. In 1863, however, after anatomical studies, the Aye•aye was revealed to be a lemur, in spite of incisor teeth that never stop growing, long, clawed fingers and other unlemur•like characteristics. Aye-ayes have a perpetually startled expression: huge, round protruding eyes dominate the face, the pupils completely surrounded by deep golden irises. Dark rings surround their eyes, heightening the eerie appearance. The rest of the face and body are gray to black, with long grizzled guard hairs. Spending the day in their twig and leaf nests, Aye-ayes emerge at night to forage for insects and fruit (Garbutt 1999). The Aye-aye's enormous ears are sensitive to the movements of insects under tree bark. At Duke University Primate Center, which has the world's largest number of captive lemurs, Aye•ayes have been filmed using their middle finger, which is twice the length of the other fingers, and skeletally thin, to tap on wood, listening for the movement of insects under the bark. When presented with a block of wood containing insect larvae in holes, the Aye•aye taps the wood and, cocking its head, can tell, even in the case of a hidden hole, the location of the insects, which it then extracts almost surgically, with its middle finger. This primate fills the ecological role of a woodpecker. Aye•ayes eat fruit as well, biting holes into the hard shells of coconuts and scraping the meat out with their middle fingers (Petter 1965). They have also been seen eating nuts of a native tree, nectar from the Traveller's Tree, fungus and lychee nuts (Garbutt 1999).

Aye-ayes have been heavily persecuted by the Malagasy, who consider them to be the embodiment of evil. In general, they are killed whenever seen. Dr. Ian Tattersall once found a dead Aye•aye with a wire pulled tight around its neck

(McNulty 1975). In 1990, apparently to dispel the bad luck caused by its having entered a village, local people set an Aye•aye tail on a pole next to the road (Simons 1993). At one time, Aye-ayes were considered among the most endangered animals in the world, facing imminent extinction. To prevent their extinction, a few were captured and released on Nosy Mangabe, a small islet off the northeast coast. Fortunately, Aye•ayes survived on the main island, perhaps because coconut plantations provided food when their forests were cut. Feeding at night, they remained undetected until recently. The Malagasy continue to persecute them.

Since the early 1980s, field surveys have revealed that Aye-ayes have a larger distribution than was originally thought. In 1991, they were seen for the first time in western Madagascar in the northern mountains (Simons 1993). With confirmed sightings in many eastern and northern forests and a few western localities, Aye-ayes inhabit a variety of forest types (Garbutt 1999). They can survive in secondary forest, coming out of their stick nests only at night. And while once thought solitary, groups of three to four individuals have been seen traveling together and feeding at foraging sites (Garbutt 1999). In spite of the greater distribution, the Aye-aye is an endangered species and almost certainly is declining (Garbutt 1999). Aye-ayes require large tracts of forest to maintain viable populations and to protect them from the persecution that often results in their deaths (Garbutt 1999). Although very rare in captivity, several captive births have occurred in recent years at the Duke University Primate Center and Jersey Wildlife Preservation Society zoo in England.

One lemur has recently been rediscovered in the wild and, in the process, an entirely new species was found. The Greater Bamboo Lemur (*Hapalemur simus*) seemed to have disappeared in the wild some time in the mid-19th century. Not until 1964 was this 5-pound, grizzled, gray-olive lemur seen again in a village market, where it was purchased by a French scientist. Unfortunately, it escaped. A pair captured in 1972 in a southeastern rainforest lived in the zoo in Madagascar's capital city, Antananarivo, until both male and female and their two offspring died (Quammen 1996).

Patricia Wright, an American primatologist, decided to search for this species in 1986 in its supposed range. Fossil evidence indicates that 1,000 years ago, the Greater Bamboo Lemur was widely distributed throughout most of Madagascar's forests, and European naturalists saw it fairly regularly in the 19th century. When she saw a russet-colored lemur clinging to a trunk, making loud "tonking" calls, Wright assumed that she had rediscovered the Greater Bamboo Lemur. Although a different color, she concluded that these animals probably represented a color variation (Quammen 1996). A German primatologist, Bernhard Meier, made independent studies in this patch of rainforest at the same time, also discovering the reddish-gold lemur. Both scientists had great difficulty making observations because of its extreme shyness (Quammen 1996). Finally one was caught, and in 1987, after chromosomal and anatomical studies were done in France, this lemur was found to be an entirely new species (Jolly 1988). It was named the Golden Bamboo Lemur (*Hapalemur aureus*) in a joint zoological paper by Meier, Wright and three other biologists (Preston-Mafham 1991). After months of unsuccessful attempts, Wright took the first photographs of the Golden Bamboo Lemur in the wild. Its beautiful golden-red face mask and belly contrast with darker brown fur on the rest of its body. (See color photographs in Garbutt 1999, Jolly 1988 and Preston-Mafham 1991). This lemur has been found at another location further north, and it is not known whether these populations are isolated from one another. Its population is apparently very low, as only about 1,000 animals have been estimated in the original location of discovery, and its habitat continues to be cleared (Garbutt 1999). The *2000 IUCN Red List of Threatened Species* has classified the Golden Bamboo Lemur as Critical, the most endangered category. Its limited range places it in great jeopardy, and it has been hunted with slingshots; its long-term survival is not secure (Garbutt 1999).

The Greater Bamboo Lemur, the animal first sought, was later found in the same forest, resembling original descriptions and clearly a separate species from the Golden Bamboo Lemur; a third species of bamboo lemur, the Gray Bamboo Lemur (*Hapalemur griseus*), weighs only 2 pounds. It has smoky gray fur and golden eyes, and lives alongside the latter two species in this same forest. This lemur lives in other parts of Madagascar as well (Preston-Mafham 1991).

Each of these three bamboo lemurs eats different parts or species of bamboo plants. One eats the leaves, another the pith, and the third confines itself to new shoots, leaf bases and pith from narrow stems (Quammen 1996). Amazingly, chemical analyses of the plants eaten by the Golden Bamboo Lemur found them to have high concentrations of cyanide, a chemical usually toxic to mammals. Golden Bamboo Lemurs weigh only about 2.2 pounds, and Wright and her co-workers found that, based on toxicity tests of other mammals, they eat 12 times the amount of cyanide that should kill them (Quammen 1996). This is another example of the biological mysteries of Madagascan wildlife.

The Ranomafana forest, with its rare and endemic lemurs and other unusual fauna and flora, would likely have been cut by the Malagasy for more farmland, but Wright spent five years in a successful effort to protect it in the newly•created Ranomafana National Park (Bohlen 1993, Mittermeier *et al.* 1992). This new park covers 108,000 acres of old-growth eastern lowland rainforest. Giant rosewood and other ancient trees tower above a lush understory. It is an extremely important--perhaps the most important--forest for lemurs. Fourteen species of lemurs and 18 other endemic species of mammals live in the park (Jolly 1988). Local people cooperated fully in setting the park™s boundaries, aware of the importance of saving forests. They had experienced a major catastrophe when a cyclone caused landslides, burying entire families in their homes, all precipitated by deforestation (Jolly 1988). In spite of these remarkable achievements, some tree cutting still occurs in Ranomafana National Park (Garbutt 1999).

Wright has continued to study lemurs, now specializing in the exquisite Diademed Sifaka (*Propithecus diadema*) (Brody 1998). Sifakas are the most acrobatic lemurs, leaping from tree to tree, but they have a unique means of locomotion to cross open spaces between trees. Standing on their long hind legs in an upright posture, they hop sideways, with their arms raised high above their heads. Sifakas can move very quickly in this amazing, dance-like gait, covering distances of more than 100 yards. They are also able to leap vertically to tree branches from a standing position, even carrying babies on their backs. One of their spectacular leaps, some 30 feet up, is the equivalent of a person jumping to the top of a telephone pole. The Golden-crowned or Tattersall's Sifaka (*Propithecus tattersalli*) is a beautiful, nearly all•white species with rich yellow-orange on the crown and tinges of this color on its back, legs and chest. Orange eyes contrast with a furless black face. The smallest of the sifakas, it is confined to a tiny area of only about 15 square miles of forest fragments in northeast Madagascar. The Golden-crowned Sifaka's small population of fewer than 8,000 animals, fragmented into isolated populations, is threatened by forest cutting, brush fires, loss of habitat to agriculture and hunting (Garbutt 1999). Distributed in discontinuous patches of forest, these sifakas may become inbred if corridors are not acquired to link populations. A core part of their forest had been scheduled for cutting for charcoal when scientists named these sifakas. The PBS Nature program, fiMadagascar. Island of Ghosts,fl was the first to film these delicate lemurs (see Video section, Regional - Africa and Indian Ocean Islands). They move about in small groups and feed on a variety of unripe fruits, seeds, shoots, leaves, bark and flowers (Garbutt 1999). No reserve has been set aside for this highly endangered sifaka, although a three-parcel national park covering 20,000 hectares (49,420 acres) has been proposed to protect this species from extinction (Garbutt 1999). The IUCN classifies this species as Critical (Hilton-Taylor 2000).

Although many Malagasy have become far more aware of the need to protect lemurs, some do not understand their rarity or the importance of conserving them. Many rural people still hunt them for food or kill them because of superstitious beliefs. In some areas, the Malagasy try to sell lemurs to foreign scientists. Visiting zoologists studying lemurs have been approached by Malagasy holding captive, and usually injured or dying lemurs, in hopes of a reward. On one occasion, an endangered species of sifaka was brought to primatologist Dr. Alison Jolly, dragged half•choked by a vine around its neck, with one arm dangling loose below the elbow, a jagged bone protruding; blood oozed down its white fur, and it gasped for air through a muzzle smashed by a flung stone (Jolly 1980). Jolly expressed horror at its condition and refused to pay them any reward. She then amazed them by telling them it was a unique sifaka, found only in that small part of Madagascar. They were incredulous . . . not in Antananarivo? . . . Not in France? . . . Not in America? (Jolly 1980). For the majority of people, lemurs are familiar animals, easy to capture and valuable as food. Malagasy schools, established by the French colonial government, taught them only about European animals, encouraging people to assume that their lemurs were unimportant. Fortunately, many Malagasy are becoming concerned about protecting lemurs, and conservation education is taught in an increasing number of schools.

Some lemurs have bred in captivity in zoos and breeding centers, but most, like the endangered Indri (*Indri indri*), have never survived in captivity long enough to breed. In their rainforests, they perch high up, clinging to tree trunks to feed, and suddenly leaping vertically to a neighboring tree, pushing off with their extremely muscular, long legs. Panda-like fur of contrasting black and white--black faces and bodies and white arms and legs--gives them a dramatic appearance. Nearly tailless and heavy--but graceful--their eerie songs, sung at dawn and sometimes during the day, form a loud chorus of high-pitched voices that carries for long distances. Indris were once very common in the eastern rainforest, but much of their habitat has been burned away, making them extremely sensitive to the danger of fires. When a 1992 fire threatened a group in a reserve, they raised such a loud cry that the guards were alerted. They rushed to the scene and put out the fire (Rajaonson 1993).

Although originally found in the far north and central highlands, the Indri is now limited to a narrow strip encompassing only half the rainforests on the island (Garbutt 1999). Indris do not reach sexual maturity until between 7 and 9 years of age, and females are thought to give birth only every second or third year (Garbutt 1999). With such a low reproductive rate, they have been very vulnerable to habitat loss and hunting, especially by immigrants (Garbutt 1999). Moving about in small family groups, they are conspicuous to hunters. The Indri is one of the few lemurs whose killing is considered taboo by the Malagasy, but the old taboos are breaking down, resulting in capture and killing. In some cases, religious leaders encourage such killing. A lemur scientist met a Catholic priest who killed several Indris, roasted them and served them to his congregation, as recorded by Faith McNulty in 1975, and this killing has not ceased. In *Mammals of Madagascar* (Garbutt 1999), two terrified Indris were photographed clinging to poles in a hut, awaiting slaughter for food.

In contrast to the Indri, mouse lemurs (*Microcebus* spp) are so small that it is hard to think of them as primates. The tiniest is the newly discovered Pygmy Mouse Lemur (*Microcebus myoxinus*), with an average weight of only 30 grams, or 1.05 ounces, smaller than any other primate (Garbutt 1999). This tiny mammal is 2.73 inches long, with a tail just under 6 inches in length (Garbutt 1999). The other species are slightly larger, with body lengths ranging up to about 5 inches, and tails of equal or greater length (Garbutt 1999). These nocturnal lemurs have huge dark eyes and are agile and active, resembling African bushbabies. They feed on insects, spiders, and even small frogs and lizards, as well as fruit, flowers and nectar (Nowak 1999). Females form groups and sleep in a nest together with up to nine individuals, while males usually nest alone or in pairs; occasionally males are found in a group of females (Nowak 1999).

A key to protecting lemurs and their forest homes is educating the people of Madagascar about them. The Jersey Wildlife Preservation Trust has put up posters with pictures of lemurs and their protected status around the island. Habitat protection is obviously key to conserving lemurs, and another recent development is the protection of the largest remaining area of rainforest in Madagascar. The Masoala Peninsula in the northeast is the sole home of the Red Ruffed Lemur (*Varecia variegata rubra*), a 9-pound, reddish subspecies of the Ruffed Lemur, but bearing little resemblance to the latter black-and-white species. With $3 million from USAID (United States Agency for International Development) and three years of planning, the new Masoala National Park, covering 210,000 hectares (518,910 acres or 840 square miles), was announced in June 1996 (Terry 1996). This immense park was formally signed into law on October 18, 1997 (Kremen 1998). Thai and Indonesian timber companies had hoped to log these virgin rainforests, but this new law will prevent clearcutting and slash-and-burn agriculture that would have destroyed the forest within less than 50 years. A coalition of organizations helped establish this park, including the Wildlife Conservation Society, CARE and the Peregrine Fund (Garbutt 1999). It will prevent the extinction of the endangered Red Ruffed Lemur, as well as that of the newly rediscovered Madagascar Serpent Eagle (*Eutriorchis astur*) (see below).

In 1997, five Ruffed Lemurs born and raised in the Duke University Primate Center in North Carolina were released in the Betampona Reserve in the northeast to bolster a small, isolated population of this species (Welch 1997). This reintroduction represented a goal in the captive-breeding program at Duke University, which has long planned such a return of these highly endangered primates to the wild. John Cleese, actor and a member of the 1970s British comedy team, Monty Python's Flying Circus, took an interest in the reintroduction program as an enthusiastic lemur admirer.

After contributing to the Ruffed Lemur reintroduction program, he wanted to see how they were faring in the wild, and trekked to their remote release site. A delightful film based on this experience, "Lemurs with John Cleese," was shown on PBS in 1999. These Ruffed Lemurs have been released in an area of dense rainforest and rugged hillsides, a long hike from the nearest road. The biologists and assistants who take part in this reintroduction program show their dedication by living for long periods under extremely primitive conditions. Cleese managed to inject humor into this otherwise arduous situation.

At least six species of lemurs, and perhaps more, serve the ecologically important role of pollinating flowers. Many of Madagascar's plants produce unusually large flowers with strong odors and copious nectars attracting lemurs to feed on them. Should any of these lemurs become extinct, the plants that they pollinate will likely follow. Lemurs also play an important role in dispersing seeds. Research by the German Primate Centre at Hamburg University has found that Brown Lemurs are crucial to the regeneration of the western dry forests. About 10 percent of the island's tree species rely largely or entirely on this species to disperse seeds, which pass through their digestive systems.

The surviving lemurs are in extreme danger of following their relatives into extinction. Conservation organizations accord them extremely high priority among endangered primates, and they are the focus of many programs to preserve them. Twenty-nine of the 33 species are listed in the *2000 IUCN Red List of Threatened Species*, all but seven in higher categories of threat. This is an increase of nine species in the four years since the previous edition of the *IUCN Red List* was published (Baillie and Groombridge 1996). Three species and several more subspecies are in the Critical category of species on the verge of extinction, while seven are Endangered, an increase of four species since 1996. All lemurs are listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the category prohibiting commercial trade, and as Endangered on the U.S. Endangered Species Act.

Although lemurs are protected by Madagascan law, hunting is a major cause of mortality. High fines and even jail sentences may be imposed for killing a lemur, but the severity of the penalties might make officials reluctant to enforce the laws (Peterson 1989). Blowguns, snares, traps, sharpened sticks, slings, stones, guns or even clubs are used to kill them (Peterson 1989). To kill small species of nocturnal lemurs, trees are sometimes cut down, and hunters seize them from their nest holes (Peterson 1989). In the late 1980s, a "sport" hunter bragged of killing 12 highly endangered Verreaux's Sifakas in one afternoon (Peterson 1989). In spite of education programs launched in the 1990s urging the Malagasy to protect lemurs, and the rise in tourists who come to see them, which provides revenues, few have benefited from tourism. Hunting remains a major threat (Garbutt 1999). The rise in human population has resulted in an increased demand for food, particularly protein, far more than the ailing agricultural system can supply (Garbutt 1999). The larger lemur species are especially affected. Because laws against killing lemurs are not enforced, much more education is needed about their potential value in attracting tourism and research funds that provide new jobs. Already tourism has raised income levels among some Malagasy, but hunger is still widespread (Tyson 2000).

In the late 1980s, a World Bank official studying the extreme and worsening poverty on the island said that there might come a time when the people of the capital city would scale the walls of the city zoo and eat the lemurs: "On the downward spiral, animals are at the bottom" (Peterson 1989). Such a tragedy is not inconceivable considering that hunger and poverty have deepened in the decade since. Conservation programs must involve communities while providing an incentive to conserve lemurs. Otherwise, it may be impossible to persuade the Malagasy not to slaughter them.

Although the status of lemurs is deteriorating along with their forests, much is being done to prevent their extinction. The past two decades have been of critical importance to lemur conservation. These extraordinary animals are receiving worldwide attention, and habitat protection for some species has been achieved. Not too long ago, their extinctions seemed inevitable and imminent. Conservation education programs, including showing slides of lemurs and other wildlife to rural children, have been launched. Wright helped to finance the building of new schools and the renovation of existing schools near Ranomafana National Park (Tyson 2000). A number of international organizations are integrating lemur and biodiversity studies with the economic development of entire communities (Garbutt 1999).

For a growing number of Malagasy, learning how special their lemurs are has made lemurs a source of pride and an important national treasure. In the future, Malagasy children may learn from an early age about lemurs and want to protect them. A few decades ago, few films had been made of these fascinating primates, while today many films show their habitats, biology and conservation work on their behalf. One is fiSpirits of the Forest,fl a charming film about many species of lemurs. Others are listed in the Video Section • Mammals. Films of lemurs and the island's environment would provide new insights about these animals if shown to the Malagasy people. Lemurs have also been prominently featured in *Madagascar: A Natural History*, by Ken Preston-Mafham, a beautiful and informative book, and the first guide book, *Mammals of Madagascar*, which provides color photos of nearly every species and subspecies, as well as information on habitats, conservation and status (Garbutt 1999).

In some areas of Madagascar, notably on Nosy Be island, lemurs are fully protected by taboo respected by the Malagasy. Here, beautiful Black Lemurs are fed by the villagers and tourists. This island is being developed intensively for tourism, and the strict nature reserve may be made into a national park (Tyson 2000). This will have mixed results, with new income flowing to the local people from park fees--one of the few countries where this occurs--yet with habitat lost and wildlife disturbed as a result of new hotels and a crush of visitors (Tyson 2000).

The gentle, curious gazes and charming behavior of lemurs have left an indelible impression on many people, and their extinction would be tragic, not just for biological reasons, but also because of their unique and delightful qualities.

The Biological Wealth of an Impoverished Country: Mammals: Page 3

Bats, which perform vital ecological roles in controlling insect populations and pollinating plants, tend to be ignored and often persecuted. Madagascar is no exception. Fifteen species of the 29 species of bats are endemic, living nowhere else (Garbutt 1999). The remaining 14 species live in mainland Africa as well. Fourteen species, or almost half the native bats, are listed by the *2000 IUCN Red List of Threatened Species*. The Yellow Bat (*Scotophilus borbonicus*), the most endangered, is listed as Critical (Hilton-Taylor 2000). This bat has been seen in both eastern and western regions but is extremely rare. A Vulnerable species, the Sucker-footed Bat (*Myzopoda aurita*), is the sole member of its family, Myzopodidae, and an extremely unusual bat. It is able to walk up tree leaves using sucker disks at the bend of its wings and on its feet to adhere to the slippery leaves (Jolly 1988). Only 2 inches long, with a forearm length of 1.9 inches, this tiny bat occurred in East Africa during the Pleistocene, but at present, it is found only in several locations in the eastern rainforest region of Madagascar (Garbutt 1999). It roosts in the Traveller™s Tree. It possesses a complex echolocation system and emits very long calls used to hunt insects (Garbutt 1999).

The largest bat, the endemic Madagascar Flying Fox (*Pteropus rufus*), has a 4-foot wing-span. An extremely colorful bat, its crown and nape are yellowish, and its upper chest and shoulders are rufous to golden brown (Garbutt 1999). It feeds on fruit juices by squeezing pieces of fruit pulp in its mouth, swallowing the juice and very soft fruit pulp, especially of figs, papayas, lychees and guavas (Garbutt 1999). Colonies of these bats roost in tall trees in primary forests or plantations (Garbutt 1999). One large roost at the Berenty reserve has decreased, apparently because of daytime disturbance by tourists who come to see them hanging upside down in the tamarind trees (Preston-Mafham 1991). Elsewhere on Madagascar, the species has declined precipitously from hunting for its meat; only on inaccessible offshore islands do these bats survive without persecution (Preston-Mafham 1991). Of Asian origin, this species is related to fruit bats in the Mascarene Islands. Through captive studies, flying foxes have been found to be extremely devoted to one another (see discussion of Rodrigues Flying Fox in Chapter One).

The Biological Wealth of an Impoverished Country: Mammals: Page 4
The Viverrid family is represented in Madagascar by mongooses, civets, and related carnivores that have evolved into eight species of three endemic subfamilies (Preston-Mafham 1991). Their ancestor is thought to have originated in Africa, and may have colonized the island at an early period. The largest carnivore on the island is the Fossa, or Fosa (*Cryptoprocta ferox*). A zoological oddity, it resembles the Jaguarundi, a neotropical cat, but most authorities place it either in the Viverrid family with civets (Preston-Mafham 1991) or the Herpestidae family with mongoose (Nowak 1999). The only member of its genus, it walks flat on its feet, rather than on its toes like cats (Nowak 1999). Sleek and slender, with golden reddish-brown fur, it has a small head with a blunt, dog-like muzzle, and an extremely long tail. Males weigh up to 22 pounds, with a body length of 2.6 feet and a tail of equal length, while the smaller females measure 2.3 feet and weigh about 15 pounds (Garbutt 1999). It has scent glands which discharge a strong odor when the animal is irritated (Nowak 1999). Widespread but rare in forests throughout the island, this nocturnal predator kills small lemurs, rodents and tenrecs, as well as birds, reptiles, amphibians, invertebrates and, reputedly, domestic chickens (Garbutt 1999). The Fossa often excavates animals from their burrows and can pursue fleeing prey by climbing up trees (Nowak 1999).

The first research study of the Fossa is being conducted by zoologist Luke Dollar, funded by the Earthwatch Institute. Helped by volunteers, he is radio-tracking several Fossa to determine their movements, habits and territory size. As the largest predator on the island, the Fossa plays an extremely important role in the evolution, behavior and population dynamics of lemurs and other prey animals. During the research project, several Fossa have shown extreme confidence by raiding the tents of the researchers when unoccupied, ransacking them and even chewing metal objects, leather boots, rucksacks, soap and bottles of malaria tablets (Garbutt 1999). For centuries, Fossas have been persecuted by the Malagasy, believing them to be ferocious and evil.

The Fossa gives birth to a litter of two to four young, which mature very slowly and may not be fully independent until they are about 4 years old (Garbutt 1999). This slow rate of reproduction has made the Fossa vulnerable to extinction. Along with losses from killing by the Malagasy, its forest home has been steadily whittled away by slash-and-burn agriculture. The Fossa is listed as Endangered in the *2000 IUCN Red List of Threatened Species*, a higher category of threat than it received in the 1996 version of this list.

Gerald Durrell, renowned author and conservationist, traveled in the western forests to capture Aye-ayes for captive breeding. He encountered a Fossa venturing out during the day--an unusual behavior: "A flash of russet red caught my eye in the bushes some six feet in front of the vehicle and, suddenly, from out of the undergrowth, silent as a cloud shadow, came a Fossa which walked languidly to the middle of the road and sat down" (Durrell 1993). Remaining there, the Fossa proceeded to groom himself, apparently unaware of Durrell's presence. Then, with a sigh and a wide yawn, the Fossa crossed the road and disappeared into the forest, "his immense sickle of a tail swinging from side to side like a bellrope behind him. To have spent ten minutes with such a rare and beautiful creature was a privilege" (Durrell 1993).

The Falanouc (*Eupleres goudotii*), sole member of its genus and a viverrid, is the size of a domestic cat. It has dense, woolly fur and an extremely pointed and narrow muzzle. Native to humid eastern lowland forests and marsh areas and portions of the northwest, Falanoucs are active at twilight and during the night. Feeding mainly on earthworms and other invertebrates, they use their long snouts and tiny, conical teeth to catch prey in leaf litter (Garbutt 1999). The species is rare or extremely rare over most of its range and is classified as Endangered by the IUCN (Hilton-Taylor 2000). Like the Fossa, it has declined as a result of deforestation, drainage of marshes, hunting by the Malagasy, attacks by feral domestic dogs, and possibly competition with the introduced Small Indian Civet (*Viverricula indica*).

The Malagasy Civet or Fanaloka has the scientific name *Fossa fossana*, which has been confused with the Fossa. Like the Fossa and Falanouc, it is the only member of its genus. Looking more like spotted civets from mainland Africa and Asia, this reddish 3-pound carnivore has rows of black spots on its back, merging into stripes toward its bushy, grayish tail. Its distribution is far more restricted than the Fossa's or the Falanouc's, being confined to eastern rainforests which have been reduced to less than 10 percent of their original size. Sheltering in tree holes or crevices, the Malagasy Civet lives in pairs and feeds on crustaceans, worms, small eels and frogs (Nowak 1999). A pair has a single young, and a captive civet lived 11 years. Hunting and trapping have also threatened the Malagasy Civet, which is listed as Vulnerable by the IUCN (Hilton-Taylor 2000).

Five other viverrids, all mongooses, are native to Madagascar, and all are threatened with extinction from a loss of forest habitat and persecution. A few have very restricted distributions. They tend to be secretive unless in a secure forest reserve, and little attention has been paid to their conservation, biology or habitat requirements. Several are uniform brown or russet, while two have bold black dorsal stripes ending in white, bushy tails. One, the Brown-tailed Mongoose (*Salanoia concolor*), is native to the northeast rainforests, but almost nothing is known of this small carnivore (Garbutt 1999). All of the eight native civets, mongooses and related animals are listed as Vulnerable or Endangered by the *2000 IUCN Red List of Threatened Species*.

The Biological Wealth of an Impoverished Country: Mammals: Page 5

Among Madagascar's 11 species of murid rodents are several extremely bizarre forms. The largest is the Giant Jumping Rat (*Hypogeomys antimena*), the size of a rabbit and weighing 2 pounds, 10 ounces (Preston-Mafham 1991). Restricted to a small area in western dry, deciduous forests north of Morondava, in west-central Madagascar, its entire range is thought to encompass only 39 square miles (Preston-Mafham 1991). Once far more widely distributed, remains have been found in southwest and central Madagascar (Garbutt 1999). These huge rodents search for food, such as fallen fruit, on the forest floor and feed by sitting on their hindquarters and holding food in their forepaws like a rabbit (Garbutt 1999). Giant Jumping Rats build deep burrows and, unlike the vast majority of rodents, a mated pair maintains long bonds with one another and with their young (Garbutt 1999). Male young leave after one year, and females stay with both parents for two to three years (Garbutt 1999). Only one or two young are born in a litter, and predation by Fossa and the Madagascar Ground Boa (*Acrantophis madagascariensis*) is high (Garbutt 1999). With no reserve and a habitat that continues to decline, this huge-eared rodent is in danger of extinction. A reserve is planned for this species, which is listed as Endangered by the *2000 IUCN Red List of Threatened Species*. fiMadagascar. Island of Ghostsfl filmed the Giant Jumping Rat in the wild, one of the only videos of this fast-disappearing species (see Video section).

Eight of Madagascar's native rodents, or 73 percent, are listed by the IUCN in various categories of threat. Two are considered Critical: the Madagascar Mouse (*Macrotarsomys ingens*) and the Madagascar Rat (*Eliurus penicillatus*). The mouse is known only from a single area in northwestern Madagascar, in dry deciduous forests where the type specimen was found, and it is thought to be almost totally arboreal and nocturnal (Garbutt 1999). The Madagascar Rat has not been seen since the type specimen was collected in central-eastern montane rainforest.

The Biological Wealth of an Impoverished Country: Birds

Page 1 (Native birds)
Page 2 (Avain & Terrestrial)
Page 3 (Aquatic)
Page 4 (Bird-watchers)

The Biological Wealth of an Impoverished Country: Birds: Page 1

Until recently, the amazing lemurs and other mammals of Madagascar eclipsed its remarkable bird life. Apart from the extinct elephant birds, 120 species of the 204 native birds are unique to the island (Morris and Hawkins 1998). Like tropical birds of other parts of the world, most are dazzlingly beautiful in brilliant hues. Unlike most tropical birds, however, they represent fascinating examples of evolution, including families of birds that exist nowhere else, having evolved from a single ancestor into many forms, some very bizarre. Most ornithologists recognize five bird families as unique to Madagascar, each with extremely distinctive characteristics. Four of these have some or all species that are threatened. The fifth, a family consisting of a single bird, the Cuckoo-Roller (*Leptosomus discolor*), is secure for the moment (Morris and Hawkins 1998). A few thousand years ago, there may have been far more native bird species that disappeared without a trace as their habitats were destroyed.

Native birds are not thriving, as people and livestock destroy their varied habitats, to which they had adapted over thousands of years. A total of 41 species, all but three of which are endemic, have been listed in the *2000 IUCN Red List of Threatened Species*, based on the research of BirdLife International published in 2000 in *Threatened Birds of the World*. The latter book illustrates each threatened Madagascan bird and describes status, population numbers, distribution and other pertinent information. The three non-endemic birds also breed in the neighboring Comoros or Seychelles (BI 2000). Thus, 20 percent of all native birds and 34 percent of endemic birds are threatened, five species listed as Critical, six as Endangered, 16 as Vulnerable, and 14 as Near-Threatened (BI 2000). Moreover, many native birds that were once widespread have become restricted to isolated forest reserves and parks, not yet endangered but far less numerous than in previous times. While the percentage of threatened birds is less than that of endemic mammals, it is significant, especially considering that 27 species are either Critical, Endangered or Vulnerable in the *2000 IUCN Red List of Threatened Species.* Madagascar has more threatened birds that all of the continental United States (excluding Puerto Rico and Hawaii). Its threatened birds total 41 threatened species, five greater than the United States™ 36 (BI 2000). Only 4 percent of the 810 breeding birds native to continental US and Canada combined (Sibley 2000) are threatened. If birds in the United States faced the same degree of threat as Madagascar's birds, at least 162 species would be threatened with extinction.

Fortunately for the future of these unique birds, organizations such as BirdLife International; the Peregrine Fund; Conservation International; the Jersey Wildlife Preservation Trust; and an ad hoc group, The Working Group on Birds in the Madagascar Region, are researching and working to conserve Madagascar's native birds. Malagasy ornithologists and members of the public are participating in surveys, studies and conservation programs. An inventory of the status and taxonomy of all of Madagascar's birds is in progress (Morris and Hawkins 1998).

In spite of Madagascar™s many unusual birds, interesting to specialists and amateur birdwatchers alike, no bird guide or text illustrating and describing the island's avifauna existed until 1990, when Olivier Langrand's *Guide to the Birds of Madagascar* was published, providing information on natural history, status, habitats and distribution, as well as color paintings of all native birds. This material supplemented the lengthy descriptions in *Threatened Birds of Africa and Related Islands*, a 1985 publication of the International Council for Bird Preservation, now called BirdLife International (Collar and Stuart 1985). *Madagascar: A Natural History*, by Ken Preston-Mafham (1991), included extensive information on many native birds and their habitats. *Birds of Madagascar, A Photographic Guide* (Morris and Hawkins 1998), published in 1998, updates the latter publications with vivid color photographs illustrating almost all native birds, including many species discovered or rediscovered during the 1990s, such as the two new species, the Cryptic Warbler (*Cryptosylvicola randrianasoloi*) and the Red-shouldered Vanga (*Calicalicus rufocarpalis*), and the rediscovery of several birds thought extinct: the Madagascar Serpent Eagle, Madagascar Red Owl (*Tyto soumagnei*) and Red-tailed or Fanovana Newtonia (*Newtonia fanovanae*). The 1990s also saw the making of many films about the island's wildlife, including its birds (see Video section).

The Biological Wealth of an Impoverished Country: Birds: Page 2
Birds native to aquatic habitats have declined even more dramatically than many forest birds. The largest lake on Madagascar, Lake Alaotra in the northeast, was once a paradise of waterbirds, turtles, frogs and other wildlife. Traditionally, portions of the lake were used by the Malagasy for rice cultivation, without serious damage to the environment or resident wildlife. But as their populations and food requirements grew, people began to destroy more and more of the natural marsh and reed beds that lined the lake, and cleared the surrounding forest for firewood and agriculture. This destroyed the lake's water quality. With no trees to hold back the soil and conserve water, this once-beautiful lake became heavily silted by runoff (Durrell 1993). Added to this, non-native tilapia fish were introduced into the lake as a food source for the local people. The fish eat vegetation needed by dragonflies and other fauna that form the basis of the lake's food chain (Preston-Mafham 1991). This ecological collapse has greatly reduced rice production on the lake, although reeds are still being cleared for rice growing, fragmenting wildlife habitat (Garbutt 1999).

The effects on native aquatic birds have been catastrophic. Lake Alaotra is the only known habitat of the endemic Alaotra Grebe (*Tachybaptus rufolavatus*), which is presumed extinct (BI 2000, Morris and Hawkins 1998). No sightings have been made since 1985, when only two birds were seen. It declined from loss of its habitat, hunting and hybridizing with the Little Grebe (*Podiceps ruficollis*), a recent arrival from Africa (Morris and Hawkins 1998). Many fruitless searches for the species have been carried out in the lake and surrounding area since then (BI 2000, Morris and Hawkins 1998). This small, black-capped grebe was very sedentary and may have been nearly flightless because of its extremely short wings.

Another waterbird restricted to Lake Alaotra, the Madagascar Pochard (*Aythya innotata*), is also probably extinct, having been eliminated by the same threats as the Alaotra Grebe (BI 2000). This duck declined steeply from 1930 on, and the last known bird, a male, was captured in August 1991, having been caught in fishing gear. This bird later died, and intensive searches in 1989 and 1990, and again in 1993 and 1994, failed to discover more Madagascar Pochards (BI 2000, Collar *et al.* 1994). A handsome bird, the pochard was chestnut-colored, with dark gray bill and yellow eyes (see photograph in Morris and Hawkins 1998). A shy species, its breeding and behavior were studied, but apparently nothing was done during its precipitous decline to prevent its extinction. Classified as Critical, hope remains that a few birds exist in wetland habitats around Lake Alaotra (Morris and Hawkins 1998).

The Jersey Wildlife Preservation Trust has begun education campaigns in the vicinity of Lake Alaotra to teach local people about the presence of the highly endangered Alaotra Reed Lemur or Bandru (*Hapalemur griseus alaotrensis*), a subspecies of the Grey Bamboo Lemur, and the importance of protecting the reed and papyrus beds. This lemur has been classified as Critical by the IUCN. The only lemur to live in an aquatic environment, the Alaotra Reed Lemur is larger than other subspecies of the Grey Gentle Lemur and lives in close, family groups (Garbutt 1999). To move about in the reed beds, they climb up a reed stem until it bends, and then walk along it to reach the next stem; their major food is the endemic papyrus, along with grasses and ferns (Garbutt 1999). Lake Alaotra's reed beds are its sole habitat, and although previously widespread in this and another lake to the north, only two isolated populations of lemurs, one of which numbers fewer than 60 animals and is on the verge of extinction, remain in marsh fragments (Garbutt 1999). This lemur has the most restricted range of any lemur species or subspecies (Garbutt 1999). The film, fiMadagascar. A World Apart,fl includes a moving segment on these lemurs feeding among the papyrus when a Malagasy canoe enters the marsh and sets a fire, causing the terrified lemurs to flee. (See Video section). Local village leaders have requested that the government set aside a protected zone in the marshes. There is hope that this lake will be brought back as a functioning ecosystem in the future and that a strict sanctuary will be set aside for this endangered lemur and the highly endangered waterbirds.

While sizeable areas of forest have been protected, few aquatic environments on Madagascar have been preserved, and native waterbird species are declining precipitously. The Madagascar Little Grebe (*Tachybaptus pelzelnii*) was once common and widespread in many parts of the island; with the pollution and destruction of marshes throughout the island for rice farms, this bird has declined greatly. The introduced tilapia was threatening this species by consuming its food supply. This grebe also hybridizes with the introduced Little Grebe (Collar *et al.* 1994). The Little Grebe, an African species which has colonized the island, prefers the habitat created by the tilapia, and is now abundant (Langrand 1990). The Madagascar Little Grebe has also drowned in fish nets, and has lost the vegetation it needed for nesting (BI 2000). It is expected to follow the Alaotra Grebe and Madagascar Pochard into extinction.

Another endemic waterbird, the Sakalava Rail (*Amaurornis olivieri*), native to western wetlands, is also extinct or nearly so. A small, sooty-black bird with yellow beak and pinkish-red legs and feet, it was native to streams and marshes in the western parts of the island. For more than 30 years, this species was not seen at all. In 1995, one was glimpsed at Lake Bemamba, and another in 1999 at the same lake (BI 2000). This species is classified as Critical (BI 2000), and Lake Bemamba and other lakes and wetlands on the west coast may be given protection by the Malagasy government, which has ratified the Ramsar Convention on wetlands preservation (BI 2000).

As a result of extensive habitat destruction and hunting, the Madagascar or Bernier's Teal (*Anas bernieri*) has likewise declined to endangered status in the few sites from which it is known on the west coast. Once widespread on the island, it is now restricted to a few marshes and shallow lakes. Small populations remain on Bemamba Lake and a few other sites (Morris and Hawkins 1998), and a flock of 67 was seen in another area (BI 2000). In 1970, 60 of these birds were seen on a lake, and as soon as this became known, European sportsmen went to the lake and killed more than 25 percent of the population (Curry-Lindahl 1972). In the 1970s, Bernier's Teal inhabited Lake Masama, but heavy hunting by both Europeans and natives with dogs has nearly eliminated them (Todd 1979). In 1993, four birds were captured for captive breeding (Collar *et al.* 1994). The Jersey Wildlife Preservation Trust is working to preserve this beleaguered species and the marshes of the west. The Madagascar Teal has been seen in three protected areas, and a conservation program at one lake has been initiated (BI 2000).

The critically endangered Madagascar Fish Eagle (*Haliaeetus vociferoides*) numbers about 250 pairs in the 600-kilometer stretch of western coastline to which it has become confined (BI 2000). This large eagle resembles the African Fish Eagle, from which it probably evolved, but instead of a snowy white head and upper body, it is streaked with brown and has shaggy, buff crown feathers. About 35 inches long, with a 6.5-foot-wingspan, it is by far the largest bird on Madagascar. Persecuted by local people, these eagles have been shot and their nests destroyed. On one occasion in the 1990s, ornithologists saw some immigrants cut the tree where an active nest of a Madagascar Fish Eagle was located, and proceed to kill and eat the chicks! The only remaining habitat for this species is the western coast, where mangrove swamps are rapidly being destroyed (Langrand 1990, Preston-Mafham 1991). The Peregrine Fund is sponsoring research on this species, and 10 nests have been located in an area on the west coast in the Three Lakes Complex (BI 2000). The Fund has removed and raised chicks that would have been killed by siblings and released them to augment the population. The fish it feeds on are being depleted, however, by a gill-net fishery that has recently been established. A new Malagasy law allows local communities to control their own resources, and the people in this region are being encouraged to formalize conservation regulations prohibiting gill netting and tree cutting.

The Biological Wealth of an Impoverished Country: Birds: Page 3

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The Biological Wealth of an Impoverished Country: Birds: Page 4

As more and more bird-watchers come to Madagascar, the government may place a higher priority on bird conservation. A special fund to which bird-watchers could contribute might be established to purchase and maintain refuges and to conduct conservation education and other projects for local people, especially in aquatic habitats. The preservation of threatened Madagascan birds has reached a critical point. The most endangered habitats, the last of the western forests, aquatic environments, and many parts of the eastern lowland rainforests, continue to decline. The fragmentation of forests that forces animals into islands of isolation needs to be studied and remedied by establishing habitat corridors between them. One Malagasy ornithologist, Aristide Andrianarimisa, is researching the effects of forest fragmentation on birds.

Pete Morris and Frank Hawkins, authors of *Birds of Madagascar. A Photographic Guide*, state that their purpose in writing their book was to inspire people to visit Madagascar and take an interest in its avifauna and the plight of so many threatened birds, as well as to promote greater interest in wildlife and conservation among the Malagasy people. Ecotourists bring revenue to the island and, thereby, help to preserve natural areas and wildlife (Morris and Hawkins 1998). The discovery of a new species of songbird, the Cryptic Warbler, by bird-watchers in Ranomafana National

Park, is an exciting byproduct of ecotourism and an indication that the study of Madagascar's birds has just begun. It also proves that amateurs play an important role in bird observation. *Birds of Madagascar* establishes a good precedent by identifying, on a species-by-species basis, the avian habitats and those birds lacking reserves within their ranges. The authors request that people coming to see the wildlife of the island let the government know why they have come in order to convince decision makers that biodiversity conservation represents a worthy investment (Morris and Hawkins 1998).

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians

The distribution and diversity of Madagascar's reptiles and amphibians have not been carefully researched until the present. Chris Raxworthy, a British herpetologist, is in the process of carrying out the first methodical survey of the estimated 500 non-marine species, all of which are endemic (Holmes 1997). To date, at least 300 reptile and about 200 frog species have been identified (Tyson 2000). This would make it one of the top five countries in the world for diversity of reptiles and amphibians. The British Isles, by contrast, with about half the land area of Madagascar, have only six species of reptiles (Preston•Mafham 1991). Even the ranges of newly described lizards and frogs will not be delineated precisely for some time. Some areas remain unexplored by herpetologists, and Raxworthy finds new species of lizards and frogs on each expedition into the tangled swamps and forest fragments. On one day when accompanied by a journalist, he and fellow researchers, including Malagasy biologists, found a bright green day gecko, a strikingly beautiful yellow-and-black snake, tiny frogs resembling lichens, a leaf-tailed gecko and 4-inch chameleons with upper legs the colors of Rainbow Trout, and lower legs like toothpicks (Holmes 1997). In a reserve on Nosy Be island, he and some Earthwatch Institute volunteers rediscovered a 10-inch green lizard that had been lost to science since the 1890s, when last collected (Tyson 2000). Raxworthy is doing inventories in reserves as part of an island-wide biodiversity program, and hopes that in some impenetrable area, giant tortoises long considered extinct will be rediscovered (Holmes 1997).

Page 1 (Threatened)
Page 2 (Tortoises and Turtles)
Page 3 (Lizards)
Page 4 (Snakes)
Page 5 (Amphibians)

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Of these native reptiles and amphibians, at least 19 are known to be threatened with extinction. A preliminary list includes 17 species of reptiles (four tortoises, a freshwater turtle, four sea turtles, a gecko, four chameleons and three boa snakes) and two amphibians, both frogs. All are in higher categories of threat: Endangered or Vulnerable by the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000). All but the sea turtles are endemic to Madagascar.

The arid regions at the northern and southern ends of Madagascar are home to two intricately patterned tortoises, both in danger of extinction. In the north is a species considered by many to be the world's most endangered tortoise: the 18-inch Madagascar or Plowshare Tortoise (*Geochelone yniphora*), whose tan, domed shell is marked with narrow black lines in delicate hexagonal patterns. The Plowshare name came about because of a protuberance on the tortoise™s lower shell that turns up, a kind of knob that remotely resembles a plowshare. This knob is used by males in sparring contests. From the 17th century onward, thousands of these tortoises, which were once abundant and widespread, were shipped every year to the nearby Comoro Islands to use as meat for settlers, driving the species to the edge of extinction before the trade finally ended in the 19th century (Juvic *et al.* 1981). Their populations never

recovered, due to the continued take by villagers for pets and the massive destruction of their habitat. Known to the Malagasy as the "Angonoka," this tortoise was headed for extinction until 1985 when the Jersey Wildlife Preservation Trust was requested by the IUCN to work with the Malagasy government in formulating a rescue plan, Project Angonoka (Reid 1995). Research on the tortoise™s wild status and behavior began immediately, and a captive-breeding program was established at a government forestry station (Reid 1995).

By 1986, eight adult tortoises had been gathered from the wild and placed in an enclosure which had ample vegetation and conditions natural enough that two male Angonokas immediately began their fights of strength (Reid 1995). Gerald Durrell, founder of the Jersey Wildlife Preservation Trust, in his book, *The Aye-aye and I* (1993), described lone males showing no interest in breeding, even if surrounded by females. But when another male is present, they face each other prepared for combat: "The two males, rotund as Tweedledum and Tweedledee dressed for battle, approach each other at what, for a tortoise, is a smart trot. The shells clash together, and then the plowshare comes into use. Each male struggles to get this projection beneath his opponent and overturn him to win a victory in this bloodless duel" (Durrell 1993). Finally, when one is able to overturn his opponent, he lumbers over to mate with the female while the vanquished male "wanders dispiritedly away" (Durrell 1993).

Project Angonoka has shown success both in captive breeding these tortoises, which may number only between 300 and 1,000 in the wild, and in working with local people to conserve remaining wild populations (Durbin *et al.* 1996). In fact, by 1995, a total of 140 captive-bred juveniles, ranging in age from 10 months to 6 years, had been produced at the breeding center. The breeding program was described in an illustrated article entitled "Observations on Hatchling and Juvenile Captive-bred Angonoka in Madagascar," published in the Jersey Wildlife Preservation Trust's annual journal, *The Dodo,* issued early in 1996. Within months, the captive-breeding program was devastated by the theft of 76 animals--two adult females and 74 hatchlings. On May 6, 1996, someone cut through the flimsy chain-link fence and the wire of the enclosure and took half the animals that were the fruit of a decade's work. Not until a female is 20 years old does she begin breeding, so the loss of two breeding females and their hatchlings dealt the program a devastating setback (McNeil 1996a). The burglary may have been an inside job, since the dog on the premises did not bark to alert the personnel who were sleeping close by (Tyson 2000). It is unlikely that these adult females will breed in captivity, as there are almost no adult male Plowshare Tortoises in breeding programs, and without more than one, no breeding occurs.

Animal smugglers care little about the effect of their actions on the survival of endangered species. Reptile collectors will pay thousands of dollars for rare specimens, and this break-in had been planned. A Dutch rare animal dealer had advertised Plowshare hatchlings for sale the month before, at $3,000 apiece, saying they would be "available soon" (McNeil 1996a). Ten of the hatchlings were traced to Prague, where wildlife law enforcement is weak, and others were suspected to be in the Netherlands, where they would be sold to collectors in the United States, Spain, Germany and Japan (McNeil 1996a). The loss of these tortoises cost the breeding program years of work. Don Reid, the Conservation Field Officer in charge of the Plowshare Tortoise captive-breeding program, had experimented for years to achieve a proper diet for the tortoises, arranged male combats, and conducted lengthy experiments to learn proper conditions for the eggs to hatch (Reid 1995). These tortoises became so tame that they would stretch their necks out to be scratched (McNeil 1996a). Although discouraged by the theft, he continued the breeding program; 40 new tortoise hatchlings were produced in late 1996, bringing the total to 130 juveniles. In 1998, several of the smuggled tortoises were seized from a Malaysian animal dealer in Mexico City who had been the subject of a long-term U.S. Fish and Wildlife Service undercover investigation. The same year, three more Plowshare Tortoises were seized in Belgium as they were being imported (TRAFFIC 1999a). The species is listed by the *2000 IUCN Red List of Threatened Species* as Vulnerable, and is protected by the Malagasy government, which bans trade.

Officials from the Jersey Wildlife Preservation Trust and other conservationists have sponsored education programs aimed at informing local people about the tortoises and their rarity. This has resulted in their cooperation in helping to guard wild tortoises from poachers and control brush fires (Durbin *et al.* 1996). This region in northwestern Madagascar has lost most of its forest cover; Arab residents cut trees and burn them to clear the land for agriculture,

and feral pigs kill the young wild tortoises (Durbin *et al.* 1996). So much clearance of natural vegetation has taken place that the climate has become increasingly more arid, causing ponds to dry up. Tree cutters are now turning to the mangroves, causing siltation of the inlets, which affects prawn harvests (Durbin *et al.* 1996) and destroys a key aquatic environment on the island.

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians: Page 2

The Plowshare Tortoises have been reduced to a few forest sites, and in spite of the urgent need for a reserve, none has been set aside. The area is getting conservation help with the formation of a new organization by conservation biologists, the Association to Safeguard the Environment. Its purpose is to involve local people in environmental projects, such as planting cashew trees, learning fire suppression methods, and trapping bush pigs; they are also giving conservation lessons to children and conducting literacy classes (Durbin *et al.* 1996).

The Radiated Tortoise (*Geochelone radiata*) inhabits the drylands of the extreme south, where the strange Didierea plants and other desert vegetation grow in open shrubland. Many people consider this tortoise to be the most beautiful in the world. Delicate yellow sunburst patterns adorn the top of its 16-inch-long black shell, and the underside is marked with diamond patterns. These tortoises also declined after tens of thousands were killed to supply local villagers with meat, or exported to the Comoro Islands from the 17th century on for meat markets abroad. In 1922 alone, 22,000 of these tortoises were exported (Jolly 1980). The legal trade did not cease until 1930. The tortoise populations have not rebounded, and illegal capture for collectors and zoos may be the explanation. The slow reproduction of this species means that it cannot quickly make up for losses in its population. An extremely long-lived species, it has evolved with low natural mortality and has few young. As an example of its longevity, a Radiated Tortoise of unknown age presented to the Queen of Tonga by Captain Cook in the 1770s, lived until 1966, making it almost 190 years old at its death (Jackson 1993).

The lovely patterns on this tortoise's shell, which vary from individual to individual, have placed it in great demand around the world, encouraging poverty-stricken Malagasy to risk jail to earn the money that these tortoises bring. Thousands of Radiated Tortoises have been collected for the international market, sold in Europe, North America and elsewhere for $2,000 or more per animal. In spite of having a range that is far larger than that of the Plowshare Tortoise, the Radiated Tortoise is declining rapidly toward extinction. The species is listed by the *2000 IUCN Red List of Threatened Species* as Vulnerable. Export and collection of Radiated Tortoises are prohibited by the Malagasy government, with severe penalties for violations including prison sentences. The United States lists both the Radiated and Plowshare Tortoises on the Endangered Species Act, which prohibits commercial importation. International commercial trade is banned by their listing on Appendix I of CITES. Still, the smuggling continues, fed by the many wealthy collectors who have no conscience about the effect their purchase has on wild populations, and the zoos that knowingly purchase smuggled animals. Malagasy authorities have failed to put an end to the poaching, especially of the Radiated Tortoise and other southern species.

Donovan Webster, a journalist, researched the rampant smuggling of Radiated Tortoises and other wildlife from the island for *The New York Times Magazine*, which published his lengthy article on February 16, 1997. The magazine cover featured the article and read: "I was caught in Madagascar. Peddled for 30 cents. Smuggled to Orlando. Sold for $10,000. I'm a rare, coveted tortoise--coldblooded contraband." Webster found that Madagascar was a "pirate's paradise," with little or no local enforcement of conservation laws. Its long and unpatrolled coastline is used by smugglers, who load tortoises onto small boats at night, with little fear of arrest (Webster 1997). Although some enforcement of capture bans takes place in the range of the Radiated Tortoise, local people have learned to avoid arrest.

The contrast between the attitudes of local people toward the Plowshare Tortoise in the north, where education

programs have been carried out by the Jersey Wildlife Preservation Trust, and the south, where no strong program exists to protect the Radiated Tortoise and other wildlife, could not be more dramatic. In the south, poaching Radiated Tortoises and other reptiles is considered an accepted form of revenue by the extremely poor people of the region. At local bars and restaurants, Webster was approached by people who offered to produce a rare snake within 24 hours. Snakes are a favorite animal for smugglers because they can be secreted in small bags and placed in luggage or, if they are small enough, in pockets. He refused a boa, which was offered at $300 and could be sold for $2,000 in the United States (Webster 1997).

Webster exposed a large-scale and fairly open trade in Radiated Tortoises in local markets within the range of these tortoises. He visited a woman who was reputed to have many of these tortoises for sale. She showed him 24 Radiated Tortoises which she kept ready for sale to anyone who would pay the right price; they were crowded into a make-shift pen in her living room, stacked two and three deep in filthy conditions (Webster 1997). They grunted and made hissing sounds when disturbed, scratching and scrabbling against one another and the pen sides; their shells were covered with dust, and most appeared to be sickly (Webster 1997). The woman tossed the tortoises back into the pile after handling them. She claimed that she sold them to local people for $1.35, and to outsiders for $4 or more, depending on how many tortoises she had at the time (Webster 1997). She also admitted supplying a smuggler who arrived once a week in a canoe at a remote beach with any Radiated Tortoises she had in stock (Webster 1997).

These tortoises are absurdly easy to collect in the wild, living in open shrubland and moving so slowly that they can be picked up as easily as rocks. Webster witnessed the capture of one mature tortoise which Benjamin, one of the collectors, located in the shadow of a boulder. When he approached, the tortoise hissed and tried to crawl beneath bushes, but it was easily grabbed, and he flipped it on its back; soon he caught two other adult tortoises who had a baby the size of a small stone wedged beneath them in an apparent attempt to protect it (Webster 1997). Collectors wrap string around the tortoises™ shells to form handles for carrying them. When they met at the end of the day, they had taken 54 mature tortoises and many young ones, making it a "banner day" (Webster 1997). The occasional presence of enforcement officers and World Wildlife Fund (WWF) representatives did not seem to present any anxiety of threat of arrest to the collectors (Webster 1997).

Each Radiated Tortoise is worth at least $2,000 once smuggled out of Madagascar, and those with unusually exquisite patterns bring as much as $10,000 (Webster 1997). Benjamin later admitted that he was aware that the tortoises were becoming rarer and that their range had shrunk in recent years; he also knew that many were very old, probably older than his own 53 years. It was obvious that the tortoises would soon be gone, but he believed this was his only potential income source; he was uncertain about how he would make a living when there were no more Radiated Tortoises (Webster 1997).

Some of the smuggled Radiated Tortoises leaving Madagascar have been seized by importing countries. In May 1992, for example, a Dutch citizen arriving from Madagascar was stopped by Customs at Roissy Airport in the Netherlands in possession of 46 Radiated Tortoises as well as 14 bamboo lemurs of several species and seven endangered Madagascar Boas (*Acrantophis madagascariensis*); the animals were confiscated and returned to Madagascar (TRAFFIC 1992). In 1998, a Radiated Tortoise was among many rare tortoises seized in Belgium as they were being imported, and U.S. authorities, under fiOperation Chameleon,fl an undercover investigation of trafficking in illegal Madagascar reptiles, seized Radiated Tortoises from an American reptile dealer in Miami. In May 1999, French Customs officers seized 450 tortoises smuggled by three Malagasy citizens living in Paris (TRAFFIC 1999b). Among them were 120 Radiated Tortoises; the suspects were not arrested (TRAFFIC 1999b).

Most ecotourism on the island has been developed for viewing lemurs, chameleons and birds, but the Radiated Tortoise and its extraordinary habitat of endemic plants have the potential of attracting many tourists. Also living in this tortoise's habitat are spectacular sifakas, many unusual birds, and other reptiles. In Beza-Mahafaly Reserve, scientists are studying the ecology and longevity of these tortoises, as well as searching for a permanent form of marking that would make them unattractive to collectors. The Radiated Tortoise could be conserved while helping local people like Benjamin. Grants from international organizations could finance jobs held by local people, such as

ex-poachers, to protect the tortoises and serve as wardens. Former collectors could help educate schoolchildren and local people about protecting Radiated Tortoises and other wildlife. Organizations, such as Earthwatch Institute, might sponsor research to study the status of these tortoises. The presence of scientists would pose a deterrent to poachers.

Two other endemic tortoises, the Spider Tortoise (*Pyxis archnoides*) and the highly endangered Flat•shelled Tortoise (*Pyxis planicauda*), are much smaller, about 5 or 6 inches long (Preston•Mafham 1991). The latter tortoise is restricted to a forest of only 40 square miles, and a captive•breeding program is attempting to prevent its extinction. Both these tortoises lay only a single, large egg (Preston•Mafham 1991). These tortoises are also in demand by reptile collectors. In August 1996, six men were indicted after being arrested with four Spider Tortoises in their luggage at the Orlando International Airport in Florida. They were part of a smuggling ring supplying rare reptiles to collectors. In 1999, 330 Spider Tortoises were seized along with Radiated Tortoises in the case cited above (TRAFFIC 1999b).

The Madagascar Big-headed Turtle (*Erymnochelys madagascariensis*), is an endangered freshwater species listed in the *2000 IUCN Red List of Threatened Species* and on Appendix II of CITES. This turtle is related to South American river turtles, another link that may date back to the time before Madagascar drifted away from Gondwana. The Jersey Wildlife Preservation Trust began a breeding program for these turtles in 1999 with the objective of releasing young turtles back into the wild after educating local people.

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians: Page 3

Madagascar is home to two•thirds of the world's chameleons--at least 62 species--more than any other country (Tyson 2000). Among the island's endemic chameleons are the world's smallest and largest species. The smallest, *Brookesia minima*, is only 1.3 inches long, while the largest, *Furcifer oustaleti*, measures 27 inches in length (Preston•Mafham 1991). Their conical eyes, moving independently, can look forward and backward at the same time, swiveling almost 180 degrees in either direction (Preston-Mafham 1991). This adaptation, processing totally divergent information spontaneously, would confuse most vertebrates, but chameleons, even very young ones, are adept at using these dual periscopes to locate insects and other prey. They hold onto the thinnest branch with their prehensile tails, and with long, thin legs bent at the knees, they walk in an odd back-and-forth swaying motion that resembles leaves moving in the wind. Their chunky bodies and spindly legs give them an awkward appearance, but they are superbly adapted to catching their prey by unfurling a long, sticky tongue--curled upside their mouth--with lightning speed, nailing an unaware insect with astonishing accuracy.

Their camouflage coloration, which varies greatly from bright greens, mottled browns, reds and blues, helps protect them from avian and mammal predators. Contrary to general opinion, chameleons do not change colors as they move about in the trees or on the ground to match their background. When they suddenly change colors, it is as a territorial or sexual display meant for other chameleons (Preston-Mafham 1991). Some species have horns and other protuberances, giving them the appearance of miniature dinosaurs. A few species show sexual dimorphism, or a physical difference between the sexes. The contrast can be so striking that some were considered separate species when first identified (Burger and Price 1996). In one species, for example, the female is black and yellow, and the male a mottled brown and white (Burger and Price 1996).

Chameleons are heavily exploited by collectors who capture them for sale in pet stores around the world, threatening them. Collectors will pay $1,000 or more per animal for rare species. This trade, which involves thousands of individuals, has caused declines in many species. The Malagasy government has banned trade in most species, but enforcement is not strong. One chameleon, *Chamaeleo brevicornis*, of which 795 were exported in the first six months of 1990, is restricted to only a few areas of primary forest (Behra 1993). An ongoing study will evaluate whether to allow trade in the commoner species. Chameleons captured and shipped abroad for the pet trade suffer very high mortality as a result of inhumane transport conditions and inadequate care in pet stores and people's homes. They

require special conditions of temperature and humidity, and many have specialized diets. In short, they are not suited to being house pets. In the care of specialists, they can be kept alive, but most captive breeding has been unsuccessful. Some of the rarer species, such as the beautiful blue-green Parson's Chameleon (*Chamaeleo parsonii*), which can reach lengths of more than 20 inches, have not been bred to the second generation**,** and mortality is high. All chameleons are on Appendix II of CITES, which requires export permits, but none has been listed on Appendix I of CITES, which would ban commercial trade.

Although some chameleons have adapted to disturbed habitats, such as weedy fields and shrub landscape, the majority favor natural habitats. The small *Brookesia* chameleons, of which one species is listed by IUCN as Vulnerable (Hilton-Taylor 2000), require undisturbed, primary old-growth forest. Three other chameleons, all *Furcifer* genus, are listed as Vulnerable by IUCN. All are in decline, approaching endangered status.

Although many Malagasy regard chameleons as ugly porters of bad luck (Burger and Price 1996), for tourists, they are the second most popular animals, after lemurs. Some Malagasy, aware of the fascination with which chameleons are held by tourists, capture them and offer them for viewing or sale.

Another lizard being captured for the pet trade is the extraordinary 4-inch-long Leaf•tailed Gecko, *Uroplatus fimbriatus*, a true master of camouflage. Resting during the day with its head tight against a tree trunk, an elaborate lacy fringe along the underside of the body allows it to melt into the tree, while its skin is patterned to resemble tree bark. Even its golden eyes are streaked with tiny dark lines that imitate bark. With broad, flattened front feet splayed out against the bark and hind legs held vertically under a spatula•like tail, it becomes virtually invisible (Preston•Mafham 1991). If discovered, however, it has a defense. Opening its mouth wide to reveal a crimson•red tongue, it raises its tail vertically and emits an ear-splitting screech, no doubt intended to be a fearsome display (Preston•Mafham 1991, Tyson 1994). Malagasy boys have discovered the haunts of the Leaf-tailed Geckos, and capture hundreds--thousands by their accounting--for sale to foreign middlemen who pay them less than $1. They are sold in the United States for $250 a pair (Tyson 1994, Tyson 2000). On Nosy Be island off the northern coast, schoolboys claim to have captured 40,000 over the past six years (Tyson 2000). A threatened gecko, Standing's Day Gecko (*Phelsuma standingi*), is native to the spiny forests of the south and is one of the most coveted by collectors (Tyson 2000). It is hunted out of many areas because Malagasy have captured hundreds, receiving $1.20 per gecko, while reporting only a few to authorities (Tyson 2000). It is on CITES Appendix II, and sells in the United States for $80 to $200 apiece (Tyson 2000). Most species of geckos bring the village collectors only about 3 U.S. cents, while the exporter receives $9 to $13 and U.S. retailers get $75 or more (Burger and Price 1996). In most cases, these pet reptiles live a very short time, and represent a mere toy to the consumer.

The export trade in live lizards involves an enormous number of animals. One gecko, *Phelsuma serraticauda*, was known only from a few museum specimens until 1,360 specimens were chronicled as exported during the first six months of 1990 for the pet trade (Behra 1993). During this same period, 22,837 lizards--geckos, *Phelsuma* genus, and chameleons, *Chamaeleo* genus--were exported from Madagascar (Behra 1993). Between 1986 and 1991, almost 145,000 lizards of 17 species were exported; of these at least 38,325 were chameleons of 21 species (Burger and Price 1996). Many of these are species that are endemic to restricted areas, or threatened in the wild. The U.S. Fish and Wildlife Service™s fiOperation Chameleonfl succeeded in arresting 19 people in 1998, among whom was a major Malaysian smuggler and an American, Tommy Crutchfield, who was arrested at Miami International Airport with suitcases full of rare snakes, tortoises and lizards. In another case, a Canadian and a Dutchman were arrested at Chiang Kai-shek International Airport in Taiwan with numerous chameleons and geckos, including some threatened Standing's Day Geckos.

Several gecko species have extremely limited ranges. A newly described leaf gecko, *Uroplatus malama*, is known from a single specimen taken in a remnant of lowland rainforest in southeastern Madagascar (Burger and Price 1996). Only two specimens of a closely related species, *Uroplatus malahelo*, exist, native to a small patch of forest in the south (Burger and Price 1996). When discovered, its habitat was being logged, and the species may already be extinct (Burger and Price 1996). An extremely rare lizard, *Zonosaurus boettgeri*, known from two specimens that were taken

in the 1890s and subsequently disappeared, has been rediscovered on the island of Nosy Be by herpetologist Chris Raxworthy and volunteers from Earthwatch Institute (Tyson 2000). The two individual lizards were killed as specimens upon rediscovery (Tyson 2000).

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Among Madagascar's 80 types of snakes--all non-poisonous--are three boas, whose closest relatives are found in South America (Burger and Price 1996). They are thought to be among the island's most ancient inhabitants, resident since the early breakup of Gondwana (Preston•Mafham 1991). All are considered Vulnerable by the IUCN (Hilton-Taylor 2000): Dumeril's Boa (*Acrantophis dumerili*), Madagascar Boa (*Acrantophis madagascariensis)*, and the Madagascar Tree Boa (*Sanzinia madagascariensis*). The first two are Madagascar's largest snakes, reaching almost 6 feet in length; Dumeril's Boa is restricted to the south and southwest, while the Madagascar Boa is found in the north and northeast (Preston•Mafham 1991). Both species require humid habitats along streams and watercourses. Placid and slow•moving, they are often killed or captured by local people. The Madagascar Tree Boa is smaller and more common, shaded in delicate grayish-green with a purplish•blue tinge. Little is known of any of these species' life histories and diets (Preston•Mafham 1994). A very rare and possibly extinct snake, *Pararhadinea albignaci*, is known only from a single specimen picked up, dead, off the road in eastern Madagascar in 1970. This species has never been seen alive in its forest home (Preston-Mafham 1991).

One of the most extraordinary snakes in the world, *Langaha nasuta*, mimics a dry, pencil-thin twig to camouflage itself among the leaves. The female's nose is extended into a leaf•shaped structure adorned with scales and small tooth•like projections, while the nose of the male is elongated, tapering into a sharp point to resemble a thorn (photo in Preston•Mafham 1991 and Lamar 1997).

A smuggling operation involving hundreds of Madagascar reptiles was exposed in August 1996, when six men were charged with conspiracy to smuggle rare Madagascar reptiles into the United States and Canada. According to the U.S. Justice Department, two men were arrested at Orlando International Airport in Florida with 61 Madagascan tree snakes in their suitcases that were to be sold at a large reptile breeders show in Orlando (Reuters 1996). Four Germans, one Canadian and one South African were indicted. Simon Harris, the South African, had $100,000 worth of rare reptiles in his luggage; he cooperated to implicate the other suspects, who are still being sought (Reuters 1996). These smugglers shipped snakes and tortoises, concealed in suitcases, from Europe to Canada and the United States and received payment by international wire transfers. Most of the snakes and tortoises were listed on CITES. In 1998, 26 Madagascan Tree Boas were seized in Belgium, and an American reptile dealer was caught by the U.S. Fish and Wildlife Service with the latter species and Dumeril's Ground Boas in his luggage at Miami International Airport (TRAFFIC 1999a).

The sea turtles inhabiting Madagascar's coastal waters are heavily exploited in spite of their listing on Appendix I of CITES. A survey in 1971 estimated that 13,000 were killed along the west coast alone (Burger and Price 1996). Little is known of their present populations.

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Some 176 species of amphibians, all frogs, have been named and described (Mittermeier *et al.* 1999). Raxworthy estimates that there are another 124, many of which have already been found but not yet described scientifically (Tyson 2000). Salamanders and toads are absent from Madagascar. All but two frogs are endemic, one of which was introduced from Asia by French colonialists as a gourmet food source (Burger and Price 1996). The majority are

native to rainforest environments, the most endangered type of habitat on the island. In one such area, a montane rainforest in the Andasibe region, 90 species are native--the highest diversity of frogs in the world (Burger and Price 1996). Since 1990, 13 new species of a single, colorful genus, *Boophis*, have been described, and others await naming by scientists (Burger and Price 1996). A candidate for the world's smallest frog--and perhaps the world's smallest vertebrate--is a minute frog, *Stumpffia pygmaea*, which measures less than 3 millimeters in length (0.117 inches) (Burger and Price 1996). This frog lays its eggs in foam nests hidden among leaves on the forest floor, and the tadpoles grow into froglets without ever feeding (Burger and Price 1996).

The most spectacular Malagasy frog may be the bright red Tomato Frog (*Dyscophus antongili*), which secretes poisonous white mucous when threatened. Some authorities consider the species to be endangered (Bauer 1995), while the *2000 IUCN Red List of Threatened Species* lists it as Vulnerable. To protect it from trade, it is listed on Appendix I of CITES. Fat and squat, this toad-like frog is large enough to cover the palm of a hand (Preston-Mafham 1991). Tomato Frogs have a very restricted range in the region of Tamatave on the east coast; some live in plantations, where pools of water gather, and even in garden ponds (Preston-Mafham 1991). Collectors, pet dealers and zoos have offered thousands of dollars for these frogs, and illegal shipments containing 40 or more Tomato Frogs have been confiscated.

One study entitled "The Export of Reptiles and Amphibians from Madagascar," by Olivier Behra (1993), chronicled the extent of exploitation of frogs. In 1988, 230 frogs of the genus *Mantella*, endemic to Madagascar, were exported. The demand increased, causing exports to rise astronomically to 11,058 in 1989; in the first six months of 1990 alone, almost 11,000 were exported, mainly to Denmark and other European countries, the United States and Japan (Behra 1993). These brightly colored little frogs are sold as pets and to decorate terrariums. The most popular Madagascar frog in this trade is the tiny Golden Mantella (*Mantella aurantiaca*), of which 3,237 were exported in the first six months of 1990 (Behra 1993). This frog is restricted to eastern Madagascar, and is apparently rare and declining (IUCN 1994). It lives in pandanus swamps in rainforests, which are rapidly disappearing, and no part of its habitat has been set aside in a reserve (IUCN 1994). Unlike most frogs, the Golden Mantella is slow-reproducing (IUCN 1994). In the 1990s, 3,000 to 6,000 were exported annually from Madagascar, and in 1994, two proposals sought to list this species on CITES, one on Appendix I and the other on Appendix II. The latter proposal succeeded, which is unfortunate, since it allows the trade to continue. The *2000 IUCN Red List of Threatened Species* lists the Golden Mantella as Vulnerable (see photos of gold and red phases of this species in Lamar 1997).

In 1998, two people were arrested in Taiwan trying to smuggle frogs of two *Mantella* species (*Mantella madagascariensis* and *Mantella aurantiaca*), along with some Madagascar lizards. Another seizure of 50 Mantella frogs occurred at Zaventem Airport in Belgium in 1998 as they were being smuggled from Madagascar (TRAFFIC 1999a). Such seizures involved shipments without the proper export permits. Appendix I listing under CITES would provide greater protection.

The Biological Wealth of an Impoverished Country: Invertebrates

Like the rest of its fauna, Madagascar's invertebrates are extraordinary. One insect from the age of the dinosaurs, the Giraffe-necked Weevil (*Trachelophorus giraffa*), has an elongated neck which rises vertically, then makes a right-angle turn and extends horizontally, and ends in a tiny head with furry antennae. Amazingly, this insect has counterparts in New Zealand known as giraffe weevils (Molloy 1994). This may be explained by the fact that New Zealand was also part of Gondwana prior to its breakup (Molloy 1994). Other ancient species include the 100 species of hissing cockroaches. Some are far larger than any other cockroach species in the world; their heavy bodies resemble long-extinct trilobites. The largest species measure up to four inches long, and thousands are exported for the novelty pet trade and for zoos. When touched, they hiss loudly, and males aggressively charge one another with their armored, knobbed shields (Preston-Mafham 1991).

One of the richest land-snail faunas in the world is native, with more than 380 species named so far, 361 of which are endemic and differ greatly from land snails in Africa (Preston-Mafham 1991). Many are threatened, however, by introduced African Giant Snails (*Achatina fulica*) and several other non-native snails introduced to control the African Giant Snail, but threatening native species instead. One native snail, *Tropidophora deburghiae*, is considered endangered by some authorities. Brilliantly colored slugs, or shell-less snails up to 6 inches long, striped in black-and-red or yellow-and-brown, live on the damp rainforest floor (Preston-Mafham 1991). Many have limited distributions and can be easily eliminated by habitat destruction (Preston-Mafham 1991).

An extremely ancient family of spiders, Archaeidae, first described from a specimen frozen in amber several million years old, has seven species on Madagascar, one in South Africa, three in Australia, five in New Zealand and one at the tip of South America; these species appear to be vestiges from the ancient supercontinent (Preston-Mafham 1991). The Archaeidae spiders have strange, grotesquely shaped bodies, visible only through a microscope since they are only 0.14 inches long; they live among leaf litter on the ground (Preston-Mafham 1991). Some Madagascar spiders are extremely bizarre, with shapes that resemble bat-winged leaves, bright red thorns, or mottled brown lumps on logs (Preston-Mafham 1991).

Millipedes on Madagascar reach 6 inches and exude droplets of poison when attacked; Brown Lemurs have found ways of avoiding this toxin and feed on them (Preston-Mafham 1991). Shield-bugs, or stink-bugs, of the family Pentatomidae, have 220 species on Madagascar, many of which are brightly colored in reds, oranges and blacks; 120 species of water bugs, of which 80 percent are endemic, and a variety of assassin bugs add to the rich insect fauna (Preston-Mafham 1991). About 20,000 beetle species, including 500 species of endemic jewel-beetles, are native to Madagascar. Jewel-beetles, with their colorful, metallic bodies, appear during the rainy season in southern and western forests (Preston-Mafham 1991). Many species of scarab beetles, among which are dung beetles, are also native to Madagascar; one endemic genus, *Helictopleurus*, roll the dung balls into their nests and lay their eggs in them (Preston-Mafham 1991).

Madagascar's butterflies, totaling 300 species, are not as diverse as in some parts of the world, such as the Tambopata Natural Reserve in Peru, which has 1,300 species. This may be because they colonized the island fairly recently. Another possibility is that many species have faded into extinction, leaving no trace, when the plant species upon which they depended were driven to extinction by habitat destruction. Since 80 percent of the island's forests have been cut, hundreds or thousands of species may have disappeared without a trace millennia ago. One Madagascar butterfly, a pale cream-and-black Swallowtail, *Papilio mangoura*, is hotly pursued by collectors because of its rarity (Preston-Mafham 1991). Several butterflies of the Nymphalidae family, or Fritillaries, are threatened, as are two species of the family Acraeidae.

In the 19th century, Charles Darwin learned of a spectacular, white Madagascar orchid (*Angraecum sesquipedale*) that had an extremely long, nectar-bearing tube dangling down from the flower. He reasoned that it could be pollinated only by an insect that could reach its nectar. He guessed that it might be "some huge moth, with a wonderfully long proboscis." Entomologists verified his belief with the 1903 discovery of the hawkmoth, *Xanthopan morgani praedicta*. This moth has a 9-inch tongue that it keeps wound in a spiral in its mouth, unfurling it to reach the nectar of this particular orchid. In a similar arrangement, another orchid (*Angraecum arachnites*), exudes a strange odor that attracts only one pollinator, the rainforest hawkmoth, *Panogena lingens* (Preston-Mafham 1991). The nectar at the base of this orchid's long, twisted tube can be reached only by this single species of moth--and not even every individual, but only one race of this moth which has a long, tapered proboscis (Preston-Mafham 1991). These species co-evolved, and should the moths become extinct, the orchids would have no pollinators and would follow them into extinction. Another unusual moth, the huge Comet Moth (*Argema mittrei*), is one of the largest moths in the world (Preston-Mafham 1991).

Preserving Madagascar's Natural Wonders

This fourth largest island in the world is, in many respects, a minicontinent. This evolutionary treasure-house is of great importance from a worldwide perspective. Madagascar's diversity of life forms is so great that as many as 200,000 species, most of them undescribed, may be native, of which an estimated 150,000 are endemic species (Daley 1997). The habitat loss is proceeding so rapidly, however, that the underfunded biological assessment studies will be unable to appraise this biological wealth before it disappears before their very eyes. Logging and burning have reduced the forested area from 120,000 to 20,000 square miles; this destruction still consumes vast areas each year (Daley 1997). It is estimated that all the remaining accessible forests will disappear within the next 35 years (Sayer *et al.* 1992). With the impending loss of these treasures, many conservationists and scientists consider Madagascar the world's most threatened natural area (Sayer *et al.* 1992).

Less than 5 percent of Madagascar is protected in reserves and parks. Even if these lands remain intact, they represent too small a percentage of forest to preserve the island's genetic heritage. Other than Masoala National Park, which encompasses most of an entire peninsula, some 840 square miles, most reserves are relatively small--islands of forest surrounded by denuded land. Should all surrounding forest be leveled, these isolated fragments would not be sufficient to prevent genetic impoverishment, inbreeding, and eventual extinction of the very species the reserves were meant to protect. Recent research in the Amazon has shown that forest fragmentation results in extinctions, in direct relation to the size of the reserve (Peters and Lovejoy 1990). The larger the reserve, the fewer extinctions. For this reason, Masoala National Park is receiving special attention from scientists. Stanford University's Center for Conservation Biology is analyzing a Geographic Information System (Kremen 1998). So far, this research has revealed that forests on the eastern border of the park are the most threatened, with a likelihood that they will be completely burned away within 25 years (Kremen 1998). The borders of the park were delineated according to the results of biological surveys, a method that is so new that it has not even been used in the United States. Claire Kremen of the Wildlife Conservation Society, with additional support from the National Geographic Society, worked with a Malagasy entomologist and two American ornithologists to conduct detailed biological species diversity studies in this rugged terrain (Kremen 1998). Five new species of butterflies and many other insects were discovered. Each had its own micro-habitat, endemic to that area. Habitats included in the national park are lowland rainforest; cloud forest and montane heath; coastal and seasonally flooded forest; mangrove; marsh; estuary; bay; lagoon; and coral reef. Lemurs and a vast array of wildlife and plants will benefit from this new park.

Masoala National Park will not displace villages but will conduct education programs and involve them in the conservation of local wildlife. The Missouri Botanical Garden is also involved in the management of Masoala National Park, helping to inventory its rare plants and working with local people for non-destructive agricultural and fisheries industries. Work is also proceeding to stop the cutting of forests for firewood on Masoala and to provide public education on land use (Sayer *et al.* 1992). Some 300 or so villages exist within or nearby Masoala National Park, and the cooperation of the local people is crucial to the success of this park. The final plan for the park involved a compromise in which some cutting of four relatively fast-growing trees, including rosewood, would be allowed. Local communities, which will profit from the products, will be allowed to harvest palm seeds and butterflies. This will prevent the slash-and-burn destruction that was eating rapidly away at this forest (Kremen 1998). This park's endemic plants and animals, including the Red Ruffed Lemur, which exists only in the park, rely for their survival on the protection of this last sizeable rainforest. It will represent an experiment in conservation management that will have serious consequences should it fail. It is, however, one of the first times that ecological rules are being worked out with large numbers of local people to help protect such a large area. Elsewhere in Madagascar, similar projects are in the works.

Many of Madagascar's rarest species are not protected in any reserves, however, and may soon be lost. Reserves and

parks, the last refuge for many species, are regularly pillaged for trees, and wildlife is killed or captured. A herpetologist surveying in Bemaraha Reserve, in the western part of the island, discovered a pile of illegally cut trees that had been marked with red paint as part of a botanist's study by the trail in 1996 (Holmes 1997). This is not an isolated occurrence. The native wildlife and plants are among the most endangered in the world. More than 124 vertebrate species are listed in the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000), as well as 306 species of plants (Walter and Gillett 1998). While this crisis is occurring, new species of lemurs, reptiles, invertebrates and plants are being discovered, making the preservation of the environment all the more urgent. Obviously, the amazing biological diversity of Madagascar has not been fully assessed and may be far greater than previously thought.

Several species thought long-extinct are rumored to survive, adding even more mystery to the picture. Many Malagasy have told scientists of having seen an animal that might be a pygmy hippopotamus. Shown a picture of an African Common Hippopotamus, they have said that it was similar, but had floppy ears, uncloven hooves, dark skin, except for pinkish areas around the eyes and mouth, and was the size of a calf or small cow (Tyson 2000). As recently as 1976, a man told biologists of having seen and heard one grunting; many unsolicited, independent accounts from Malagasy have agreed on these details (Tyson 2000). They call the animal "kilopilopitsofy," and many are afraid of being chased by it (Tyson 2000). The Common Hippopotamus of Africa also grunts and kills more people than any other animal on the continent.

A long-lost primate, ground-dwelling and the size of a 7-year-old child, has also been reported by several Malagasy (Tyson 2000). This may be the same animal that was described to primatologist Alison Jolly (1980). A Malagasy told her that he had been given a young lemur of a type he had never seen before. This lemur had very dark fur, walked on its hind legs, one foot after the other, rather than hopping like a sifaka, and had a flat face different from the pointed muzzles of living lemurs. After only two months, this lemur died, and its skeleton was buried in an unknown place (Jolly 1980). An old man recently told a similar story of having seen such an animal in 1952. Called the "kidoky" by others who have seen it, it has a dark coat with white spots above and below a flat, round face. When alarmed, it flees by leaping forward in short hops like a baboon. Its call was described as a long, single whoop, and other villagers who had seen the animal said it was solitary (Tyson 2000). Scientists have said that if it exists, it might be an *Archaeolemur* or *Hadropithecus* (Tyson 2000). The fact that their descriptions seem so similar to species known to have existed makes them all the more intriguing.

Alarm calls about the impending demise of Madagascar's natural world have been sounded for decades (Jolly 1980, 1988; McNulty 1975; Preston•Mafham 1991; Tyson 2000). Visitors to the island are united in their descriptions of a ravaged, eroded and deforested land. Jacques•Yves Cousteau and his team visited the island for a television special aired in 1995. As they sailed toward Madagascar, they were stunned to see huge, wide, red stains of eroded soil in the water, emanating from the island's rivers, and wisps of smoke from burning forests. These red rivers are bleeding the island's life blood, its topsoil. They are so pronounced that they are among the few natural phenomena on Earth visible from orbiting space craft. Cousteau's helicopter flights over the central plateau revealed a landscape among the most devastated on the planet. A research team sponsored by Earthwatch Institute described the island from the air, "Two features of the landscape stood out even from 10 kilometers up: barrenness and smoke" (Tyson 1994).

Although erosion remains a major problem, some progress has been made to stop it (Morell 1999). Erosion costs Madagascar between $100 million and $290 million per year, caused mainly by the continued slash-and-burn agriculture (Tyson 2000). It has been extremely difficult to convince many Malagasy that the last of the forests will disappear within a generation if they do not seek alternative means of growing crops. To that end, Cornell University's International Institute for Food, Agriculture and Development, run by Norman Uphoff, has been helping farmers in the vicinity of Ranomafana National Park (Tyson 2000). These desperately poor farmers have no electricity or plumbing and struggle to feed large families on soil that is leaching its nutrients. Norman Uphoff discovered that the native Wild Ginger plant had high concentrations of phosphate, and he encouraged its use as fertilizer (Tyson 2000). By supplying seedlings and information, the Cornell program also has helped establish fish farms. Their agronomists have advised farmers to mix crops and to plant certain species in order to keep the soil rich and retard erosion; they

have supplied seedlings (Tyson 2000). This agricultural advice has been helpful, but because some rural people have so many children, many are unable to produce enough crops to feed their families (Tyson 2000). Other projects involve encouraging rice cultivation with more suitable seed varieties, improved irrigation systems and application of fertilizer (Garbutt 1999). Using native bees in honey-making is also being taught to the Malagasy, who often fell old-growth trees to obtain honey (Garbutt 1999). The Kew Botanical Gardens in London and Britain's Royal Palm Society are researching the marketing of seeds from some native palm trees (Terry 1996).

International aid organizations could help preserve forests by donating fertilizer so the Malagasy would not need to practice slash-and-burn when forest soil ceases to produce crops. The urgent task of supplying the Malagasy people with methods of producing food and fuel in environmentally non-destructive ways has just begun. Villagers would be more likely to preserve trees now cut for firewood if they were provided with solar cookers or given propane tanks for fuel. Bio-gas, or methane, produced by animal dung and sewage, could be used to provide fuel and fertilizer. Such projects have been launched by international agencies in some countries of Central Asia.

Madagascar's human population is growing at a rate of 3.1 percent per year and reached 12,596,000 in 1992 (55 persons per square mile) (Anon. 1994). By 1995, it had grown to 13.9 million (61 persons per square mile) (McNeil 1996b). Another increase to 14,462,509 people (64 persons per square mile) was registered in the 1999 *World Almanac*. The *2001 New York Times Almanac* noted a population of 15,506,472, based on a July 2000 estimate. Thus, 3 million people were added to the population in just eight years. Along with the original Asians, more recent immigrants from Africa, India, Pakistan, China, Europe, and Arab countries add to the diversity. They have long since passed the carrying capacity of the land, and rice must be imported to feed the people. As one of the world's 12 poorest countries, Madagascar's external debt is approximately $4.25 billion. Average annual income is only $780 (NYT 2000). The unemployment rate is about 33 percent, and 51 percent of children are malnourished, according to a study by USAID (Tyson 2000). The literacy rate is 46 percent, and only 42 percent of children attend schools; 70 percent of children ages 6 to 9 have had no formal education (Tyson 2000). Jacques Cousteau's team filmed hordes of desperately poor people as they combed dumps for scraps of metal and food. Some people even live in these dumps in holes they have dug in the soil. Such scenes are symptoms of extreme overpopulation and rampant poverty that can also be seen in parts of Brazil and Asia.

One of the reasons that illiteracy is so high in Madagascar is that millions of people must spend their days searching for food, water and firewood, requiring the help of their children, who are then unable to attend school. In general, foreign corporations have looted the island's resources, leaving no economic base that would help the people as a whole. One U.S. company, the Esso Corporation, is owed $25 million by the Madagascan government and demanded payment in spite of the country's cash reserves of less than $2 million (McNeil 1996b). Because of the country's debt levels, the World Bank and the International Monetary Fund are now in charge of its finances (McNeil 1996b), a potentially dangerous situation for both the people and the environment. On the positive side, a "Debt for Nature" swap was carried out in Madagascar, in which a portion of the foreign debt was exchanged for the establishment of nature reserves and parks.

To date, efforts to slow the population growth rate are still in their early stages. A program that addresses population growth, based not on threats or punishment, but on persuasion, was launched by Population Communications International (PCI) of New York City in 1996. As the organization has done in other countries, it trains local people to create communication programs for radio and television with a message that limiting family size is advantageous. The majority of the population on the island lives in cities and has access to these media. The programs, described as "soap operas" by PCI, create melodramas with characters the audience can identify with, who act out dramas. The characters in these dramas come to realize that different behavior, such as having fewer children, will result in positive changes in their lives (Ryerson 1994). In many cases, this involves elevating the status of women, and convincing men that women must be allowed to make decisions about their own reproduction (Ryerson 1994). PCI is cooperating with organizations that are actively trying to conserve the wildlife of Madagascar, such as Conservation International and the African Wildlife Foundation. Ranomafana National Park began a family planning center in 1994 to help the people of the region, many of whom have as many as 14 children, of which 62 percent are underweight and 17 percent

malnourished, according to a study by the University of North Carolina (Tyson 2000).

Madagascar is a magnet for scientists from around the world and has been the recipient of millions of dollars in foreign aid and grants from international conservation agencies. Conservationists are initiating many highly inventive and effective programs to interest the Malagasy in conservation and employ them in biodiversity work. Environmental education is a key to the future of Madagascar, and programs are being carried out at Beza-Mahafaly Reserve. This protected portion of endangered spiny desert and shrubland was established when the local Mahafaly people agreed to donate the land, and funds were raised by Alison Richard, a Yale primatologist, for a training program for Malagasy scientists (Tyson 2000). Patricia Wright has set up a similar program in which Malagasy students complete master's theses based on wildlife research in Ranomafana National Park, and some students travel to the United States to receive advanced training in biodiversity and environmental protection (Tyson 2000). They will help guide the country in new directions in the future. It also opens new worlds to these students, who, in turn, will make young people aware of the natural treasures in their country. Schools that Patricia Wright has helped establish in the area of the park teach environmental education to young people. Others are also helping introduce this subject to children. Josephine Andrews, a Scottish scientist studying Black Lemurs in Nosy Be since 1988, teaches children about the lemurs with the help of a Malagasy named Julien, who guides people around the forest preserve (Tyson 2000). "If the kids are really into it, then the adults will switch on as well," she said (Tyson 1994). Forests are the key to the future survival of the island and its people, and an education program aimed at rural people, teaching the value of trees in preventing floods, landslides and in maintaining the flow of rivers and streams, could save countless trees.

Scientists--both Malagasy and foreign--working on the island, could share their findings by talking with local people about the uniqueness of Madagascar's natural world. Ornithologists with the Peregrine Fund, who rediscovered the Red Owl and taught local schoolchildren about the species donated money from bird-watchers to the school, provided such an example. Scientists typically conduct research and depart without having taught local people about their findings. Villagers near Ranomafana National Park were so interested in learning about research results that they asked Wright for copies of reports. She began a bimonthly newsletter, in the Malagasy language, describing the natural history of the park (Tyson 2000).

Films and books about Madagascar's wildlife and plants tend to be distributed only in foreign countries, and never translated into Malagasy. Translations of books and subtitled films could be shown to schoolchildren to introduce them to Madagascar's tremendously interesting and beautiful natural world. It is ironic that Westerners may be more familiar with lemurs and chameleons that most Malagasy. Some projects for the future might include donation of solar collectors and windmills to supply power to rural people. This could elevate their standard of living and cut back on firewood collection for fuel. Donation of projection and video equipment to regional schools provided with electricity would help them appreciate their natural heritage through viewing nature films of Madagascan wildlife. Satellite dishes would facilitate communication with people around the world through the Internet.

The government of Madagascar developed a 20-year National Conservation Strategy and Environmental Action Plan as long ago as 1984. In 1986, a survey of protected areas began with the aim of implementing management plans for priority protected areas and recommending new protected areas, as well as training Malagasy people to work in reserve management and conservation biology. The government has been working to create a sense of pride and ownership in the nation's biodiversity through this program (Morell 1999). The President of Madagascar has stated that the environment is important, a key to whether foreign scientists and tourists will be able to come to the country and aid in its conservation in the future (Tyson 2000). The World Bank and various organizations funded this Environmental Action Plan with $168 million for its first five years (Tyson 2000). This has resulted in many biological studies, education of a growing number of Malagasy for conservation work and a Biodiversity Planning Centre (Sayer *et al.* 1992). The Geographical Information System database is a cornerstone of the government program, concentrating data from all fields to help establish conservation priorities (Tyson 2000). Conservation International has an office in the capital and is contributing to biological inventory data, as it has in other countries, as well as conducting research on particular species and data management. It coordinates its work with local organizations and trains Malagasy scientists (Sayer *et al.* 1992).

Ecotourism is another budding industry, and Madagascar is one of the few countries in the world to share park fees with local people. As a result of an initiative put forth by a Malagasy non-governmental organization, the National Association for the Management of Protected Areas, one-half of all fees are given to local people (Tyson 2000). Ninety-three villages in the Ranomafana National Park area received about $10,000 in a recent year from park fees; a committee designated by the villages decides how to spend the money. In 1995 they bought seeds and built campgrounds, a crafts training center and small dams (Tyson 2000). Many local people are employed as park workers, and the aim of the program is to turn over management of this park and its biodiversity work to the Malagasy people. There needs to be a national park system with strict rules for management and protection, according to Patricia Wright, who deplored the illegal tree cutting by the previous park director at Ranomafana (Tyson 2000). She also has proposed that a national biodiversity institute be built, which would offer centralized training in biology and technology, as well as five new long-term biodiversity research stations similar to those in La Selva National Park in Costa Rica and the Smithsonian Institution's Panama tropical research laboratory (Tyson 2000).

Jobs, which are desperately needed by the Malagasy, are increasing as a result of the rise in the number of tourists. Selling crafts to tourists, running hotels and restaurants, and serving as guides are among these. Villagers who used to demand that parks be declassified so that they could legally gather wood, now request that more national parks be established, an apparent result of the new income that comes from fees and tourism (Morell 1999). International tourists have provided a major new source of revenue in Madagascar's economy and are helping the Malagasy see their wildlife in a new way, as so fascinating and biologically important that visitors come from every continent to view it. *Madagascar. The Bradt Travel Guide*, by Hilary Bradt (1999), published in various editions since 1988, is a useful aid for tourists, providing information about accommodations, natural history, protected areas, and the Malagasy and their history. Nature reserves and parks provide jobs by attracting scientists who employ local people, another incentive for the Malagasy to urge that more protected areas be set aside.

Compensation for lost access to forests has not been paid in the past, and new arrangements reached with villagers to allow some extraction of resources from the forests may heal some of these wounds and placate those who still wish to cut trees. Medicinal plants obtained from Madagascar may be another source of revenue in the future. The Rosy Periwinkle may be only one of many native plants highly valuable in treating disease. Research on the potential of other plants may uncover other such treasures. In the past, revenues from plants used for medicine have not been returned in part to the country of origin, but recently a new trend has begun. In one case, a pharmaceutical company agreed to pay people in a South American country a portion of the revenues gained from any native plant providing a marketable drug.

Another potential source of revenue is the placement of videocameras connected to the Internet, which present websites with general information as well as live camera views of wildlife. South African parks have a number of these videocameras placed at water holes, animal dens and other key areas that capture live views of animals transmitted to the Internet for a small viewing fee. This has proven very successful, funding many of the South African National Parks system™s expenses. A similar system could be established in Madagascar with solar-powered videocameras, which have already been in use in Alaska, trained on tree canopies, rainforest flowers or lemurs, along with websites that provide basic information on Madagascar's environment, biodiversity and the Malagasy people. For millions of people who cannot visit Madagascar, such a website might be fascinating as a learning tool for teachers and the public, as well as an exciting view of these unique animals and their environments. If managed in such a way that profits were shared between poor Malagasy to alleviate their poverty, and conservation organizations to preserve biodiversity, such a system has great potential.

A satellite connection with classrooms in the United States or other countries would be another opportunity for interactive communication and learning. In December 2000, for example, students in an American classroom talked with students in a school in Guyana about endangered Giant Otters and their conservation through a visual satellite hookup. Students and others might set up an interactive link with biologists and conservationists working in Madagascar, asking questions and offering help. Students have provided many excellent ideas for conservation, and

classes have raised money to save rainforests and threatened wildlife habitat and to help stop poaching of endangered species in countries half a world away from their own. Malagasy young people might be inspired and enthusiastic through talking with others of their own age about conservation and biodiversity. Video cameras and still cameras might be donated to Malagasy students and young people to record nature and compete for prizes with their results.

Madagascar™s Lessons

Madagascar's story is one of ecological catastrophe and the gradual extermination of its life forms. One's first response might be that its experience is as far from the rest of the world as it is geographically remote. However, it is from the extremes that one acquires basic knowledge. The effects of immigrants, whether human, animal, plant or disease, can devastate natural ecosystems wherever they occur. Islands are especially vulnerable to the effects of invasive species, including humans, because their flora and fauna have limited habitats and tend to be endemic, with small populations.

Exotic or non-indigenous species threaten 350 species of birds, or 30 percent of all threatened birds listed by BirdLife International in *Threatened Birds of the World* (BI 2000). Likewise, 361 plant species and 69 species of mammals listed by the *2000 IUCN Red List of Threatened Species* are threatened as a result of non-indigenous species (Hilton-Taylor 2000). The effects of invasive species, including humans, have been the major cause of extinction of virtually all bird species, almost all of which have occurred on islands. In the case of Madagascar, the Malagasy and other immigrant peoples and their livestock, and their subsequent hunting and habitat destruction, presented the vulnerable native species with threats against which they had no defense. Islands throughout the world continue to suffer losses in biodiversity, as do areas with large numbers of endemic species in mainland areas. Species with restricted ranges are the most likely to go extinct or become endangered. Such species dominate the list of birds in *Threatened Birds of the World* (BI 2000). In this age of international commerce, where plant diseases and other viruses are brought into countries in shiploads of lumber or ballast water, and exotic animals and plants continue to colonize and be released in delicate ecosystems with endemic species, whether on islands or mainlands, it has become extremely difficult to defend native species from such invasions. Nevertheless, through preserving native plants and animals and legislating against such introductions, while removing non-native species, ecosystems and their diversity can be protected. Preserving natural ecosystems is vitally important, not just for wildlife preservation, but for humans as well, so that precious water supplies, topsoils and biological diversity, which stabilize all ecosystems, are protected. These lessons have not yet been put into practice in Madagascar or in many other parts of the world, including developed countries. Ecological and faunal changes may be so gradual that they go unnoticed until ecosystems have been destroyed.

Madagascar Testing Quotes

About 500 A.D., immigrant people from Asia, most probably Indonesia or Malaysia, arrived on Madagascar's shores in hand-hewn canoes, bringing domestic animals with them. They began clearing forests and burning them for farmland, and turned lakes and wetlands into rice paddies. Cleared land produced crops for only a few years until the thin soil became sterile. Farmers then moved on to other parts of the forest, in this slash-and-burn agriculture. At some point, African herdsmen colonized the island, bringing zebu cattle, which crowded out wildlife (Tyson 2000). Gradually, abuse of the land eroded the soil in the central highlands to bare earth, pocketed and gouged by deep gullies and cavernous holes. This region had harbored a great variety of lemurs, along with a wealth of birds, reptiles and unique plants. Throughout the island, wildlife declined as habitats disappeared, isolating animals in smaller and smaller patches of forest and wetlands. The large lemurs, tortoises and elephant birds were avidly hunted.

Within 600 years of the arrival of the Malagasy, extinctions claimed many native animals. Several elephant bird species, the larger lemurs and many native plants vanished. Two kinds of pygmy hippos inhabited the island. The Madagascar Hippopotamuses (*Hippopotamus lemerlei*), an amphibious species, and *Hippopotamus madagascariensis*, a forest species, were both about 6.5 feet long and 2.5 feet tall, smaller than the Common Hippopotamus of Africa, which is about 10 feet long (Tyson 2000). From genetic and anatomical analysis, both seem to have evolved from the latter species (Tyson 2000). The hippos had been widely distributed and very common prior to the arrival of the Malagasy (Dewar 1984). Their bones have been found with marks indicating that they had been butchered (Tyson 2000). Both died out long before Europeans arrived. The native crocodile, whose large bones have been found, is believed by some scientists to represent large specimens of Nile Crocodiles, the species native today (Tyson 2000). It is thus possible that the crocodile survived. A large mongoose-like viverrid, *Cryptoprocta spelea*, and a very unusual aardvark-like animal, *Plesiorycteropus madagascariensis*, died out at an early date (Dewar 1984).

Prior to the arrival of humans, elephant birds had been abundant in most parts of the island, as attested by the prevalence of their bones. There were two genera, and from six to 12 species of these birds (Tyson 2000). It is likely that the flightless birds fell prey to the primitive weapons of the Malagasy and were crowded out of their habitats by livestock (Tyson 2000). The last to die out was the Great Elephant Bird (*Aepyornis maximus*), which may have survived until recent times by retreating to remote swamps. Dr. Alexander Wetmore of the Smithsonian Institution examined bones of a Great Elephant Bird unearthed in archeological excavations in the 1960s. He was amazed by their size: "The incredible femur, or thighbone, of this ponderous bird is by far the largest I have ever seen" (Wetmore 1967). Estimated to weigh at least 1,000 pounds, more than three times the weight of an Ostrich, it produced eggs larger than any dinosaur's, with a capacity of 2 gallons (equivalent to seven Ostrich eggs), 180 chicken eggs or 12,000 hummingbird eggs (Bradbury 1919, Fuller 1987). When one was X•rayed, the bones of an embryo three•fourths developed were revealed (Wetmore 1967). Something had interrupted the embryo's growth and frozen it within the eggshell for hundreds and perhaps thousands of years (Wetmore 1967).

Despite its fearsome size, the Great Elephant Bird lacked a hooked beak for tearing prey and was plainly not a predator (Wetmore 1967). Its large, clawed feet may have helped it defend itself against the small native predators but were not enough to protect it from Malagasy arrows. Its short legs prevented it from running as fast as its relative, the Ostrich, but it may have been quite agile when chased. This vegetarian bird browsed and cropped plants, able to reach with its long neck to the lower branches of trees (Wetmore 1967). By the mid-16th century, when Europeans had managed to establish a foothold in Madagascar, the new French Governor, Sieur Etienne de Flacourt, wrote in 1661 that the Great Elephant Bird was still found in the south of the island, "seeking the most deserted places" to avoid human hunters (Tyson 2000). Villagers of Antandroy told of an Ostrich-like bird that was difficult to catch, according to Flacourt (Tyson 2000).

The exact date this giant bird became extinct is not known with certainty. Alan Feduccia (1996), an eminent paleo-ornithologist, asserts that elephant birds of many species were still widespread in the 10th century but gradually disappeared as a result of human activity. He cites an account by a French merchant sailor in 1848, who visited Madagascar and saw the shell of the Great Elephant Bird; he was told that it belonged to the chief and that the bird that produced such eggs "is still more rarely seen" (Feduccia 1996). Some authorities estimate that it died out in the mid-17th century, although there is no proof that any European ever saw one of these birds (Tyson 2000). It has been suggested that Europeans were responsible for the bird™s extinction by hunting and destroying its habitat (Quammen 1996). But Thomas Brooks (2000) of the Center for Applied Biodiversity Science, Conservation International, asserted in a list of extinct birds in *Threatened Birds of the World* (BI 2000) that all the elephant birds had disappeared by 1500. In a bizarre footnote to this species' epitaph, an *Aepyornis* egg washed up on Australia's western coast in 1995. No conclusive explanation for this strange event has been put forth, although it is likely that it became unearthed from long interment by rains, and washed out to sea. Much less is known of the other species of elephant birds, which existed in a variety of sizes down to a chicken-sized species.

Lemur-like primates once lived on many continents, but nowhere had they evolved into such a great variety of species. When the Malagasy people arrived some 1,500 years ago, lemurs occupied every habitat, even marshland. A

species as tall as a man must have startled the Malagasy immigrants, giving rise to legends that these animals had superhuman powers. The first French naturalists were told by the Malagasy that these primates were thought to be the ghosts of sacred ancestors of man, inspiring the genus name Lemur, the word for ghost in Latin. The Malagasy considered some lemurs sacred and punished anyone who harmed them, but most species were feared as evil demons and were killed on sight.

From their arrival on Madagascar, the Malagasy hunted the larger species of lemurs, almost all of which are now extinct. Archaeological excavations show that they formed a staple in the immigrants' diets. Such diggings have unearthed the skulls and bones of long•extinct lemurs in early Malagasy jars and kitchen middens; their heads had been split by ax-heads made from an extinct flightless bird (Jolly 1980).

In the centuries following colonization by the Malagasy immigrants, some 15 species of lemurs of eight genera became extinct (Mittermeier 1997). These extinct lemurs were, for the most part, far larger than surviving species and had evolved to fill many ecological niches. Three *Megaladapis* lemurs weighed between 90 and 170 pounds and moved slowly through the trees, feeding on foliage (Tattersall 1993). Another species, *Archaeolemur*, was about the size of a female baboon and lived on the ground (Tattersall 1993). Two *Palaeopropithecus* species weighed between 90 and 130 pounds and were sloth•like tree dwellers with flexible bodies (Tattersall 1993). These extinct lemurs had evolved many unusual means of movement and locomotion that have no parallels in living species of lemurs.

Largest of all, the massive 400•pound *Archaeoindris* was apparently a ground•dweller, moving on all fours; many of its anatomical characteristics are unlike any living primate (Tattersall 1993). One entire lemur family, Archaeolemuridae, was obliterated. In this family were many species of lemurs weighing between 35 and 55 pounds; they were powerfully built and short•legged (Tattersall 1993). The heaviest lemur surviving today, the Indri (*Indri indri*), weighs only about 15 pounds (Tattersall 1993). These lemurs had survived for millions of years, and their extinctions were indeed a major biological loss to the planet. According to primatologists, the surviving lemurs resemble the very earliest primates from the Eocene (Tattersall 1993). Like prosimians in Africa and Asia, but to a far greater degree, lemurs have a highly developed sense of smell. Some species have long, fox-like noses (Preston-Mafham 1991). Genetic analysis of their DNA has revealed that all lemurs are descended from a single ancestor that probably arrived from Africa about 60 million years ago (Garbutt 1999).

The Giant Aye-aye (*Daubentonia robusta*) lemur was somewhat larger and 2.5 to 5 times heavier than the surviving Aye-aye (see below), but in other respects was very similar (Garbutt 1999). It is known from subfossil remains found in southwestern Madagascar (Nowak 1999). The date of its disappearance is unknown but may be fairly recent.

Archaeologists have uncovered remains of a massive bird of prey, the Malagasy Crowned Eagle (*Stephanoaetus mahery*), which undoubtedly preyed on lemurs (Feduccia 1996). In fact, at one locality the diet of this eagle, based on the bones of eagles and lemurs found together, contained at least 80 percent primates, including specimens weighing up to 26.5 pounds (Feduccia 1996). Remains of another large eagle of the genus *Aquila* have been discovered, and it, too, preyed on large lemurs and became extinct after the arrival of the Malagasy. These extinct birds preyed on smaller lemurs as well, including some species still surviving (Feduccia 1996). A bird of prey flying overhead still elicits fear in lemurs, causing them to seek cover. Neither of the two remaining species of eagles on Madagascar preys on lemurs, but two hawk species have been seen preying on young lemurs (Garbutt 1999).

In addition to the Giant Elephant Bird, the large Snail-eating Coua (*Coua delalandei*), a member of the cuckoo family, became extinct. The last specimen of this large, slate-blue bird was taken on an islet off the east coast, Ile Sainte-Marie, in 1834 (Morris and Hawkins 1998); reports by observers who claimed to have seen the bird were recorded as late as 1930 (Fuller 1987). The causes of this bird's disappearance, and even its exact range, remain obscure (Langrand 1990). Many specimens of this bird were taken before its extinction and kept in museums in Leiden; London; New York; Paris; Philadelphia; Tananarive (Madagascar); and Cambridge (Massachusetts) (Fuller 1987). The long feathers of this bird were highly valued by the Malagasy, and hunting may have reduced its numbers to a critically low level (Fuller 1987). It is also possible that the many birds killed for zoological specimens may have

pushed this already rare bird to extinction, since its distribution may have been limited to the tiny Ile Sainte-Marie. No reliable record exists of its presence on the main island of Madagascar, but there is hope that it might be found in lowland forest near the Bay of Antongil (Morris and Hawkins 1998). Ten closely related species of couas survive, all smaller than the Snail-eating Coua.

Madagascar Testing Quotes 2
Testing "quotes again" to see whether they are "going" to have 'slashes' added to them or not.

Madagascar and other Islands

Madagascar

Imagine an island more than 1,000 miles long in a blue tropical ocean. Forests cover vast areas, interspersed with swamps where crocodiles 8 meters long lie in wait to prey on pygmy hippopotamuses. Thousands of giant tortoises with shells 4 feet across lumber about. In the forests and in dryer parts of the island live some of the strangest primates to have ever existed on Earth. Some 45 species of these lemurs live throughout the island and range in size from the world's smallest primate, weighing about 1 ounce, to a lemur the size of a Gorilla (Tattersall 1993).

Huge white birds plod along forest trails and through savannah grasses. Many kinds of these birds inhabit the island. The largest resembles an Ostrich, but is far more massive in build, weighing 1,000 pounds (Feduccia 1996). It stands 10 feet tall and lays 20-pound eggs, 13 inches long (Feduccia 1996, Greenway 1967). More than 100 other kinds of tropical birds that exist nowhere else fly in forests and deserts and wade in still marshes.

Primitive hedgehog-like mammals, called tenrecs, scurry in forest underbrush. One type of tenrec lives in cold mountain streams, swimming with webbed feet and flattened tail, while another has spines like a porcupine and stripes down its back like a skunk. It communicates with its young by vibrating its spines.

Hundreds of kinds of amphibians and reptiles inhabit forests, aquatic environments, savannahs and drylands. Frogs of every imaginable color and pattern leap in green shadows. Chameleons, some brilliantly colored, and others shades of mottled brown, creep invisibly about. The largest, 2 feet long, can capture mice and birds, while the smallest, measuring only 1.5 inches, feeds on insects (Amos 1980). Tortoises with shells adorned in delicate yellow sunburst patterns inhabit shrub and deserts.

Plants exist in unparalleled variety, a botanical paradise. Relicts of species long-extinct on mainland areas--tall tree ferns, palms, red-flowered flame trees, massive deciduous and rainforest trees, giant tamarinds and aloes, desert oddities, and baobabs of many sizes--grow in even the driest parts of the island. Orchids in a rainbow of colors bloom among the deep green rainforests. Waterfalls abound, cascading down tall cliffs into rivers and lakes. Along the west coast, a dry deciduous forest stretches the length of the island**.** The central highlands are a mosaic of woodland and savannah, while the eastern regions are covered in dense, humid rainforest. In the extreme south, a desert environment prevails, harboring *Didierea*, strange cactus-resembling plants that form long, spiny, twisted shafts rising 30 feet into the air. An impenetrable wilderness of limestone spikes and sharp rocks dominates the far north. Rare birds and lemurs find refuge in this craggy landscape and feed in oases watered by meandering streams.

Flightlessness, fearlessness, gigantism, dwarfism, and survival of ancient species all occurred in this evolutionary laboratory. That such a large land mass went uninhabited by humans for so long is truly remarkable. Nowhere else on the planet has such a large land area remained isolated for such a prolonged period, allowing a flowering of diverse

life forms to flourish and adapt to the island's many habitats and terrains in this mild, tropical climate. Such is the history of the island from Madagascar in 400 A.D., a century before the arrival of the Malagasy people of Asia. Had humans reached Madagascar earlier, it might not have evolved its diverse, yet vulnerable, fauna and flora.

How such an extraordinary diversity of animals and plants inhabits Madagascar is tied to its geological history. Some 160 million years ago, when Africa, Australia, New Zealand and South America were united in the super-continent Gondwana, Madagascar was attached to eastern Africa and what is now peninsular India. Dinosaurs, giant turtles, crocodiles, primitive mammals, reptilian birds and lizards roamed on this massive land mass. Gondwana gradually broke apart as a result of movements of tectonic plates covering the Earth's crust. For many millions of years, India and Madagascar formed a mini-continent. Then, about 88 million years ago, they split along Madagascar's east coast, and peninsular India moved northward toward Asia (Garbutt 1999, Tyson 2000). Paleontologists have only recently discovered that Madagascar was home to dinosaurs and other primitive animals quite unlike those found in other parts of the world. The oldest known species of dinosaur, dating back 227 million years, may be the ancestor of all dinosaurs (Flynn 2000). One dinosaur had teeth that were clove-shaped (Stenzelt and Thiessen 2000). Seven species of crocodiles inhabited Madagascar from the Cretaceous period onward, including a pug-nosed vegetarian species (Flynn 2000). About 65 million years ago, the last dinosaurs died out, concurrent with their extinction throughout the world. Some native plants and animals survived from the time when Madagascar was part of Gondwana. Giant tortoises, crocodiles, boas, tenrec ancestors and possibly an early form of elephant birds may have lived on the super-continent, although most ornithologists are certain that the ancestor of the elephant bird flew to the island and became flightless (Feduccia 1996). Plants of many kinds, virtually unchanged from their ancient forms, grow on the island.

Immigrant animals arrived during the millennia from many sources. Because Madagascar separated from India and Gondwana long before the evolution of the prosimians that were the ancestors of the lemurs, these primates must have come from mainland Africa, where their close relatives, bush babies and galagos, survive today. Some scientists believe they might have traveled over a land connection that existed between Africa and Madagascar at some point (Tyson 2000). Others dispute that there ever was such a land bridge and maintain that they arrived by sea, perhaps sheltering on large mats of floating vegetation or clinging to uprooted tree trunks that swept down mainland rivers to the sea and washed up on Madagascar's shores. Few modern mammals of Africa, whether baboons, monkeys, gazelles, antelope or other hoofed mammals, reached Madagascar. The hippopotamuses must have originated in Africa, but how they came to the island is another mystery.

Over many millennia, a blossoming of evolution occurred in this mild, tropical climate of Gondwandan and immigrant species, radiating into entire new families and creating a flora and fauna of great diversity unlike any in the world. Birds, bats and insects flew or were blown to the island by wind currents and storms from Africa and Asia. No large carnivores arrived, however. The largest mammal predators are relatives of mongooses, primitive viverrids. Grazing and browsing roles were filled by hippopotamuses, land tortoises, lemurs and elephant birds.

Human Settlers Invade Paradise

About 500 A.D., immigrant people from Asia, most probably Indonesia or Malaysia, arrived on Madagascar's shores in hand-hewn canoes, bringing domestic animals with them. They began clearing forests and burning them for farmland, and turned lakes and wetlands into rice paddies. Cleared land produced crops for only a few years until the thin soil became sterile. Farmers then moved on to other parts of the forest, in this slash-and-burn agriculture. At some point, African herdsmen colonized the island, bringing zebu cattle, which crowded out wildlife (Tyson 2000). Gradually, abuse of the land eroded the soil in the central highlands to bare earth, pocketed and gouged by deep gullies and cavernous holes. This region had harbored a great variety of lemurs, along with a wealth of birds, reptiles

and unique plants. Throughout the island, wildlife declined as habitats disappeared, isolating animals in smaller and smaller patches of forest and wetlands. The large lemurs, tortoises and elephant birds were avidly hunted.

Within 600 years of the arrival of the Malagasy, extinctions claimed many native animals. Several elephant bird species, the larger lemurs and many native plants vanished. Two kinds of pygmy hippos inhabited the island. The Madagascar Hippopotamuses (*Hippopotamus lemerlei*), an amphibious species, and *Hippopotamus madagascariensis*, a forest species, were both about 6.5 feet long and 2.5 feet tall, smaller than the Common Hippopotamus of Africa, which is about 10 feet long (Tyson 2000). From genetic and anatomical analysis, both seem to have evolved from the latter species (Tyson 2000). The hippos had been widely distributed and very common prior to the arrival of the Malagasy (Dewar 1984). Their bones have been found with marks indicating that they had been butchered (Tyson 2000). Both died out long before Europeans arrived. The native crocodile, whose large bones have been found, is believed by some scientists to represent large specimens of Nile Crocodiles, the species native today (Tyson 2000). It is thus possible that the crocodile survived. A large mongoose-like viverrid, *Cryptoprocta spelea*, and a very unusual aardvark-like animal, *Plesiorycteropus madagascariensis*, died out at an early date (Dewar 1984).

Prior to the arrival of humans, elephant birds had been abundant in most parts of the island, as attested by the prevalence of their bones. There were two genera, and from six to 12 species of these birds (Tyson 2000). It is likely that the flightless birds fell prey to the primitive weapons of the Malagasy and were crowded out of their habitats by livestock (Tyson 2000). The last to die out was the Great Elephant Bird (*Aepyornis maximus*), which may have survived until recent times by retreating to remote swamps. Dr. Alexander Wetmore of the Smithsonian Institution examined bones of a Great Elephant Bird unearthed in archeological excavations in the 1960s. He was amazed by their size: "The incredible femur, or thighbone, of this ponderous bird is by far the largest I have ever seen" (Wetmore 1967). Estimated to weigh at least 1,000 pounds, more than three times the weight of an Ostrich, it produced eggs larger than any dinosaur's, with a capacity of 2 gallons (equivalent to seven Ostrich eggs), 180 chicken eggs or 12,000 hummingbird eggs (Bradbury 1919, Fuller 1987). When one was X•rayed, the bones of an embryo three•fourths developed were revealed (Wetmore 1967). Something had interrupted the embryo's growth and frozen it within the eggshell for hundreds and perhaps thousands of years (Wetmore 1967).

Despite its fearsome size, the Great Elephant Bird lacked a hooked beak for tearing prey and was plainly not a predator (Wetmore 1967). Its large, clawed feet may have helped it defend itself against the small native predators but were not enough to protect it from Malagasy arrows. Its short legs prevented it from running as fast as its relative, the Ostrich, but it may have been quite agile when chased. This vegetarian bird browsed and cropped plants, able to reach with its long neck to the lower branches of trees (Wetmore 1967). By the mid-16th century, when Europeans had managed to establish a foothold in Madagascar, the new French Governor, Sieur Etienne de Flacourt, wrote in 1661 that the Great Elephant Bird was still found in the south of the island, "seeking the most deserted places" to avoid human hunters (Tyson 2000). Villagers of Antandroy told of an Ostrich-like bird that was difficult to catch, according to Flacourt (Tyson 2000).

The exact date this giant bird became extinct is not known with certainty. Alan Feduccia (1996), an eminent paleo-ornithologist, asserts that elephant birds of many species were still widespread in the 10th century but gradually disappeared as a result of human activity. He cites an account by a French merchant sailor in 1848, who visited Madagascar and saw the shell of the Great Elephant Bird; he was told that it belonged to the chief and that the bird that produced such eggs "is still more rarely seen" (Feduccia 1996). Some authorities estimate that it died out in the mid-17th century, although there is no proof that any European ever saw one of these birds (Tyson 2000). It has been suggested that Europeans were responsible for the bird™s extinction by hunting and destroying its habitat (Quammen 1996). But Thomas Brooks (2000) of the Center for Applied Biodiversity Science, Conservation International, asserted in a list of extinct birds in *Threatened Birds of the World* (BI 2000) that all the elephant birds had disappeared by 1500. In a bizarre footnote to this species' epitaph, an *Aepyornis* egg washed up on Australia's western coast in 1995. No conclusive explanation for this strange event has been put forth, although it is likely that it became unearthed from long interment by rains, and washed out to sea. Much less is known of the other species of elephant birds, which existed in a variety of sizes down to a chicken-sized species.

Lemur-like primates once lived on many continents, but nowhere had they evolved into such a great variety of species. When the Malagasy people arrived some 1,500 years ago, lemurs occupied every habitat, even marshland. A species as tall as a man must have startled the Malagasy immigrants, giving rise to legends that these animals had superhuman powers. The first French naturalists were told by the Malagasy that these primates were thought to be the ghosts of sacred ancestors of man, inspiring the genus name Lemur, the word for ghost in Latin. The Malagasy considered some lemurs sacred and punished anyone who harmed them, but most species were feared as evil demons and were killed on sight.

From their arrival on Madagascar, the Malagasy hunted the larger species of lemurs, almost all of which are now extinct. Archaeological excavations show that they formed a staple in the immigrants' diets. Such diggings have unearthed the skulls and bones of long•extinct lemurs in early Malagasy jars and kitchen middens; their heads had been split by ax-heads made from an extinct flightless bird (Jolly 1980).

In the centuries following colonization by the Malagasy immigrants, some 15 species of lemurs of eight genera became extinct (Mittermeier 1997). These extinct lemurs were, for the most part, far larger than surviving species and had evolved to fill many ecological niches. Three *Megaladapis* lemurs weighed between 90 and 170 pounds and moved slowly through the trees, feeding on foliage (Tattersall 1993). Another species, *Archaeolemur*, was about the size of a female baboon and lived on the ground (Tattersall 1993). Two *Palaeopropithecus* species weighed between 90 and 130 pounds and were sloth•like tree dwellers with flexible bodies (Tattersall 1993). These extinct lemurs had evolved many unusual means of movement and locomotion that have no parallels in living species of lemurs.

Largest of all, the massive 400•pound *Archaeoindris* was apparently a ground•dweller, moving on all fours; many of its anatomical characteristics are unlike any living primate (Tattersall 1993). One entire lemur family, Archaeolemuridae, was obliterated. In this family were many species of lemurs weighing between 35 and 55 pounds; they were powerfully built and short•legged (Tattersall 1993). The heaviest lemur surviving today, the Indri (*Indri indri*), weighs only about 15 pounds (Tattersall 1993). These lemurs had survived for millions of years, and their extinctions were indeed a major biological loss to the planet. According to primatologists, the surviving lemurs resemble the very earliest primates from the Eocene (Tattersall 1993). Like prosimians in Africa and Asia, but to a far greater degree, lemurs have a highly developed sense of smell. Some species have long, fox-like noses (Preston-Mafham 1991). Genetic analysis of their DNA has revealed that all lemurs are descended from a single ancestor that probably arrived from Africa about 60 million years ago (Garbutt 1999).

The Giant Aye-aye (*Daubentonia robusta*) lemur was somewhat larger and 2.5 to 5 times heavier than the surviving Aye-aye (see below), but in other respects was very similar (Garbutt 1999). It is known from subfossil remains found in southwestern Madagascar (Nowak 1999). The date of its disappearance is unknown but may be fairly recent.

Archaeologists have uncovered remains of a massive bird of prey, the Malagasy Crowned Eagle (*Stephanoaetus mahery*), which undoubtedly preyed on lemurs (Feduccia 1996). In fact, at one locality the diet of this eagle, based on the bones of eagles and lemurs found together, contained at least 80 percent primates, including specimens weighing up to 26.5 pounds (Feduccia 1996). Remains of another large eagle of the genus *Aquila* have been discovered, and it, too, preyed on large lemurs and became extinct after the arrival of the Malagasy. These extinct birds preyed on smaller lemurs as well, including some species still surviving (Feduccia 1996). A bird of prey flying overhead still elicits fear in lemurs, causing them to seek cover. Neither of the two remaining species of eagles on Madagascar preys on lemurs, but two hawk species have been seen preying on young lemurs (Garbutt 1999).

In addition to the Giant Elephant Bird, the large Snail-eating Coua (*Coua delalandei*), a member of the cuckoo family, became extinct. The last specimen of this large, slate-blue bird was taken on an islet off the east coast, Ile Sainte-Marie, in 1834 (Morris and Hawkins 1998); reports by observers who claimed to have seen the bird were recorded as late as 1930 (Fuller 1987). The causes of this bird's disappearance, and even its exact range, remain obscure (Langrand 1990). Many specimens of this bird were taken before its extinction and kept in museums in

Leiden; London; New York; Paris; Philadelphia; Tananarive (Madagascar); and Cambridge (Massachusetts) (Fuller 1987). The long feathers of this bird were highly valued by the Malagasy, and hunting may have reduced its numbers to a critically low level (Fuller 1987). It is also possible that the many birds killed for zoological specimens may have pushed this already rare bird to extinction, since its distribution may have been limited to the tiny Ile Sainte-Marie. No reliable record exists of its presence on the main island of Madagascar, but there is hope that it might be found in lowland forest near the Bay of Antongil (Morris and Hawkins 1998). Ten closely related species of couas survive, all smaller than the Snail-eating Coua.

The Biological Wealth of an Impoverished Country

The Madagascar of today is still a remarkable place, although about 90 percent of the forests, including almost all lowland rainforests that were richest in wildlife, were destroyed (Mittermeier *et al.* 1999). Some 33 lemur species survive, along with all but one species of tenrec, various mongooses and their relatives, more chameleons than any other country, several hundred kinds of frogs and reptiles, and thousands of endemic invertebrates and plants. Madagascar has no native fish, but many introduced species. Its fauna and flora represent many extremely unusual and unique examples of evolution (Mittermeier *et al.* 1999). This island is considered one of the five most biologically important areas in the world; its primates are the world's highest priority for conservation (Mittermeier *et al.* 1999).

The Biological Wealth of an Impoverished Country: Forests and Plants

Madagascar has one of the richest floras in the world. Eighty percent of its plants are found nowhere else (McNeely *et al.* 1990, Preston-Mafham 1991). The diversity of plants that survived almost 2,000 years of forest destruction continues to astound biologists and conservationists. Tropical trees with fruit growing on their trunks (various species of the genus *Tambourissa*) are native, as is a cactus (*Rhipsalis*), related to American species, that lives in the rainforest. A tree, *Symphonia*, which has leathery leaves and red-and-white striped flowers that look like peppermint candies (Morell 1999), also survives. The Flame Tree (*Delonix regia*), which produces cascades of red flowers, is grown around the world for its beauty, but few realize that it originated in Madagascar (Preston-Mafham 1991). Miraculously, many endemic plants have survived the fires and tree cutting that have destroyed much of the island. One mountain chain has 150 endemic vascular plants, a very high number (Preston-Mafham 1991). They are among the 7,300 to 12,000 species of plants native to Madagascar (Preston-Mafham 1991). Its flowering plants make up 20 percent of all the plants in the African region (McNeely 1990). At least 191 botanical families, a very large number for a relatively small area, evolved from ancestor species (Preston-Mafham 1991).

Some 2,000 years ago, the eastern rainforest stretched in a band 100 miles wide from north to south, covering 27 million acres (Tyson 2000). Ninety percent of the plants were endemic, with a profusion of unusual ferns, some types growing on tree trunks; wild ginger, with delicate purple flowers; bamboos; and far more orchids than in an African rainforest (Preston-Mafham 1991). An early traveler described the woods as so dense that there was a fideep gloom: below the canopy at mid-day (Tyson 2000). Rainfall must have been greater and general climate more humid than at present as a result of these extensive rainforests. In the montane ridges, huge tree ferns, mosses and lichens cover the ground and hang from tree branches (Preston-Mafham 1991). Over the centuries, Malagasy burned many portions of

the rainforest, especially in the south. Few tall trees remain in the rainforest today, although at one time there must have been many giants. During the 19th century, a palace was built for a woman ruler, centering on a 130-foot tree that had been carried by 5,000 laborers from the eastern rainforest (Tyson 2000). The palace was destroyed by an uprising in the 1850s. About this time, Malagasy dragged a tombstone through the forest, cutting 25,000 trees just to make a path (Tyson 2000). Early decrees banned cutting of virgin forest, with severe penalties, in the 19th century, but these were largely ignored (Tyson 2000).

About half of the island's forests had been cut by the late 19th century, and intensive cutting continued in the 20th century (Tyson 2000). The prime lowland forests throughout the island and three-fourths of the rainforest were cleared by the French for growing coffee and other crops in the first three decades of the century (Tyson 2000). The rainforest was heavily logged between 1950 and 1985, with 275,000 acres cleared and burned each year (Tyson 2000). The northeast Masoala Peninsula still retains sizeable areas of unlogged rainforest, but the southern region has been reduced to fragments of the original unbroken expanses. The remnants tend to be on sharp ridges where soil is poor and access difficult. For example, Ranomafana, a recently declared national park, straddles such an escarpment. Even so, many of its trees had been removed prior to its protection (Tyson 2000). What was once a closed-canopy, humid rainforest is now far dryer and cooler, with many openings among the trees, and some illegal logging continues (Tyson 2000). Still, botanists from the Missouri Botanical Garden, who were conducting a census of the trees in this park, counted 37 families of trees with 105 species in a 1-hectare plot (Tyson 2000). Outside the park's boundaries, rainforest is still being cleared and burned by the Malagasy, many of whom believe that their wealth lies in the amount of land they clear (Morell 1999).

The western dry, deciduous forest lies in the shadow of eastern mountains, which block moist ocean air currents (Preston-Mafham 1991). Trees do not attain heights of more than 80 feet, but many types of plants have adapted to this environment. Liana vines grow among the trees, and dead leaves carpet the forest floor. Large tamarind trees grow along rivers, and baobabs grow in plateaus (Preston-Mafham 1991). Beautiful orange bell flowers of the *Ipomoea carnea* plant burst into bloom during the short rainy season. As with the eastern rainforests, the once continuous stretches of deciduous forests have been largely destroyed, replaced by grasses able to survive in the eroded or bare soil.

Throughout the island, most deforested areas fail to regenerate into second-growth forests, even when left fallow, because Madagascar lacks vigorous colonizing trees that can quickly protect cleared ground and prevent further erosion (Preston-Mafham 2000). Cleared hillsides become covered in non-native grasses and exotic South American trees (*Psidium cattleyanum* and *Psidium guajava*) or plantations of eucalyptus, which inhibit the establishment of native seedlings (Preston-Mafham 1991; Sayer *et al.* 1992). Only if soils are rich and remnants of original forest are nearby will native forests regenerate. Unfortunately, the original forests and their native wildlife are lost permanently, and even regeneration cannot take place without a cessation of the slash-and-burn cycle, known as fitavyfl by the Malagasy (Preston-Mafham 1991). Moreover, foreign logging companies have obtained logging concessions on most of the unprotected remnants of native forest. Tree cutting consumes some 7.8 million cubic meters of wood per year, of which 7 million cubic meters is for fuel and charcoal (Sayer *et al.* 1992). Valuable timber trees have been logged to extinction in most of Madagascar. The two native species of ebony trees of the genus *Diospyros* have been heavily logged for centuries, and few large trees are left (Sayer *et al.* 1992). The understory plants, such as tree ferns, are also exploited, dug up to sell as potted plants (Sayer *et al.* 1992).

The net result of this logging and burning, especially in the barren central highlands, is the loss of "a priceless reservoir of plant and animal species, replaced by one of the most impoverished forms of vegetation on the planet" (Preston-Mafham 1991). Many species of trees and other plants are highly endangered. Madagascar is one of the world's 12 "hot spot" areas of tropical forests, having a high percentage of endemic species which are under great threat (McNeely *et al.* 1990). Since an estimated 94 percent of Madagascar's trees are endemic, and many occupy very restricted ranges, they are highly vulnerable to extinction. Further research will likely reveal even more threatened species. Some authorities believe that even this rich plant diversity must represent only a fraction of the "vast original flora," since 80 percent of the vegetation and forests is gone (Ayensu *et al.* 1984). The *1997 IUCN Red*

List of Threatened Plants includes 19 species of plants that may have recently become extinct, and an additional 287 species that are threatened with extinction (Walter and Gillett 1998).

Resident since the days of the dinosaurs, trees of a family of primitive pines, Podocarpaceae, grow on the island. The family is represented by species in other parts of the world that were part of Gondwana, from South America west to Southeast Asia. Madagascar has a number of native Podocarps, of which four endemic species or varieties are listed by the *IUCN Red List* as either Vulnerable or Rare (Walter and Gillett 1998). At least 26 genera of plants are native to Madagascar and South America, but not to Africa, and are believed to be remnants from Gondwana (Preston-Mafham 1991). Another one of these, Madagascar's national tree, the Traveller's Tree (*Ravenala madagascariensis*), is a palm-like species of the banana family (Musaceae). Its closest relative of the same genus grows in Brazil and Guiana, but not in Africa (Preston-Mafham 1991). This tree has leathery petals covering its pollen and nectar and is a key food source for both bats and lemurs. In return, it depends on lemurs for pollination. Lemurs feed on the nectar, getting their noses covered with pollen in the process. They are so fond of the nectar that they travel miles to find another Traveller's Tree, still carrying the nectar on their noses and, unknowingly, pollinate the next tree they feed on (Attenborough 1995).

A plant of the Winteraceae family that has been growing on the island for 30 million years was recently seen again after a period of 90 years (Hsu 1997). This tree, *Takhtajania perrieri*, has many primitive features, such as a lack of vessels to move water and minerals; like many of Madagascar's relict species, it once grew on much of continental Africa, but long ago disappeared there (Hsu 1997).

Madagascar has more palms (Palmae family) than all of Africa (Preston-Mafham 1991). Many are in danger, however. The *IUCN Red List of Threatened Plants* lists 148 native species in various categories (Walter and Gillett 1998). The Big-leaf Palm (*Marojeya darianii*) was chosen by the Species Survival Committee of the IUCN to be one of 12 critically endangered species highlighted at its 1988 General Assembly in Costa Rica. This species was only discovered in 1982 and is confined to a single swamp in the northeast (Prance 1990). An agricultural program to raise rice cleared half its habitat, and then failed. This huge-leafed palm has been over-harvested as a source of heart-of-palm, a commercially valuable product (Prance 1990). Huge palms are felled for their inner pith to supply this gourmet market. The majority of palms grow in the eastern rainforests in a great diversity of size. Two threatened palms, *Dypsis hildebrandtii* and *Dypsis louvelii*, are miniature delicate-fronded palms only 3 feet high (Preston-Mafham 1991). Others, like the threatened *Ravenea glauca*, are majestic giants with long, straight trunks rising 50 feet or more to a luxuriant crown. Palms do not often survive the fires set by the Malagasy to clear land, disappearing from one area after another (Preston-Mafham 1991).

On the entire continent of Africa, only one species of baobab tree is native, while seven species are found in Madagascar (Preston-Mafham 1991). These strange-looking trees have wide trunks that taper to a narrow crown, looking like upside-down trees. Some baobabs grow to immense size. One famous specimen measures 46 feet around the base of the trunk (Preston-Mafham 1991). Another species, *Alluaudia ascendens*, grows in the southern desert. Although it can reach a maximum height of 16 feet, it is usually far smaller (Preston-Mafham 1991). Each of the seven species has a slightly different shape and size, but all have gray bark that resembles unwrinkled elephant skin. Baobabs are extremely important to both wildlife and humans. The Malagasy cut holes in their massive trunks and hollow out the spongy pith where water accumulates. In the dry south, these trees become wells, and villagers set ladders against the trunks, climb to the hole cut from the trunk, and lower buckets into the pool of water. Natural holes in baobob trunks and branches provide important nesting holes for birds and lemurs. These trees are fire-resistant, and fortunately, they are worthless as timber because of their soft, pulpy cores. For this reason some stands of thousands of huge, very old baobabs remain in parts of the island. Because of the heavy livestock grazing, few young baobab seedlings can survive, however, and botanists believe that the spectacular vistas of these behemoths will gradually disappear (Preston-Mafham 1991).

One very strange group of Madagascan plants native to dry areas has nine species in the same genus, *Pachypodium*. These succulent plants lose their leaves at the onset of the dry season and have evolved into a variety

of forms, all with gray, smooth bark. Eight of the nine species are threatened with extinction, according to the *IUCN Red List of Threatened Plants* (Walter and Gillett 1998). One of these, the endangered *Pachypodium decaryi*, is native to Antananarivo, the "tsingy" limestone crags of the northwest. Its smooth, silvery trunk resembles a large inverted turnip, fat at the base and tapering upward, topped by a messy mop of thin, straggly branches (Preston-Mafham 1991). It bears large, white flowers during the dry season. Its main population occurs in the Ankarana Special Reserve, which bans burning (Preston-Mafham 1991), but has recently been invaded by hordes of miners who are clearing vegetation to search for sapphires (Morell 1999). Other Pachypodiums have equally bizarre shapes, such as the bulbous *Pachypodium rosulatum*, which resembles a huge gourd sprouting long, thin shafts from which its bright yellow flower bloom. The rare *Pachypodium densiflorum*, with the appearance of a domestic jade plant run amok, has a mass of short, gray branches sprouting from a squat gray base. All these plants are highly susceptible to fire. Ken Preston-Mafham, in *Madagascar: A Natural History*, describes the threat of "incessant brush fires which ravage the length and breadth of central Madagascar during the dry season. Within hours, hillsides which had been decorated with colorful rock gardens of rare succulents are converted into graveyards of charred embers." These brush fires have been intentionally set by Malagasy to improve grazing land for their cattle or clear land. Another threat to Pachypodia is collectors who tear specimens, especially bizarre forms, from mountain slopes (Preston-Mafham 1991). Few species are protected in reserves. Without strong conservation programs, these fascinating plants could easily disappear.

Other strange trees of the southern spiny desert include the Octopus Tree (*Didierea madagascariensis*), a member of an endemic family of 11 cactus-like species, Didiereaceae. This tree has no trunk, but a bouquet-like grouping of stems covered in long, needle-sharp spines that branch out in odd, twisted shapes. Although resembling cacti, this family has no close relatives anywhere in the world (Preston-Mafham 1991). Another member of the family, *Alluaudia procera*, has a thick trunk with very long spines that grow in curving rows upward, and small, rounded leaves along its branches. In spite of this, several lemur species are able to leap onto these plants without hurting themselves (Preston-Mafham 1991). Three species in this family, all of the *Alluaudia* genus, are Rare, according to the IUCN (Walter and Gillett 1998). One of these, *Alluaudia montagnacii*, has tall, solitary tapering stems ending in a tuft of flowers.

The discovery of the medicinal effects of the endemic Rosy Periwinkle (*Catharanthus roseus*) has saved thousands of human lives. Two potent alkaloid compounds found in this plant have proven effective in the treatment of Hodgkin™s' Disease, producing a 99 percent remission in patients with acute lymphocytic leukemia (Myers 1983). It also contains 75 different alkaloids, which could produce commercial substances (Preston-Mafham 1991). Fortunately, the Rosy Periwinkle is easy to propagate, grown in greenhouses around the world. Ongoing research is uncovering other Madagascan plants of medicinal value. Samples of plants are being tested in laboratories, and elderly Malagasy healers are being consulted. More than 50 species of wild coffee (*Coffea* spp.) grow in the island's eastern rainforests, providing an important genetic base for hybridizing with other strains because of their insect-resistance and low level of caffeine (Preston-Mafham 1991). These plants are symbolic of the great botanical wealth at risk.

The Biological Wealth of an Impoverished Country: Mammals

Home to some of the world's most fascinating, beautiful and curious mammals, Madagascar has approximately 117 native species, 90 percent of which exist nowhere else (Garbutt 1999). Excluding bats, all 88 native terrestrial mammals are endemic to Madagascar. Three-fourths of native mammals, or 66 species, are threatened with extinction; 49 of these are in higher categories of threat listed in the *2000 IUCN Red List of Threatened Species*. This represents 42 percent of all mammals found in Madagascar, by far the greatest percentage of threatened mammals of any country in the world (Hilton-Taylor 2000). As new species of mammals continue to be discovered, the numbers that are threatened continues to rise. A few have not been seen in the wild since their discovery. The majority is made of

forest-dwellers, and a few inhabit marshy areas or woodland streams. The loss of forest, predation on them by Malagasy and domestic dogs, and introduction of exotic species of mammals that out-compete native species are combining to push many of the island's mammals toward extinction.

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The publication of *Mammals of Madagascar*, by Nick Garbutt, in 1999 filled a void for a complete guide to all native mammals, illustrated with color photos of most species and major habitats. This supplemented *Madascar: A Natural History* in 1991, an important reference on mammals and their environment. Conservation work has focused mainly on lemurs, with many organizations involved, including Earthwatch Institute, which sponsors field research; Conservation International; Jersey Wildlife Preservation Trust (based in England); and CARE. Several of these groups sponsored biodiversity studies and helped establish national parks, benefiting thousands of species, including tenrecs and other native mammals. A growing number of Malagasy zoologists are taking part in studies and conservation work, and new programs have been initiated to help local people while conserving mammals and their environments. Certain mammals have received inadequate attention to date, notably bats, rodents and some viverrids, who will undoubtedly benefit from the swell of interest and enthusiasm for Madagascar fauna that has developed in recent years. Filmmakers have recently produced a number of excellent wildlife documentaries, photographing rare species and spreading knowledge and concern about endangered mammals (see Video section).

Among Madagascar's mammals are many primitive forms. The tenrecs' closest relatives are insectivores known as solenodons, native to Cuba, Hispaniola and other vestiges of Gondwana in the Caribbean. Tenrecs and solenodons may have had a common ancestor living on the supercontinent, progenitor of all mammals. The remains of similar species have been found in Africa and South America, indicating that they were once very widespread but died out on all but isolated refuges such as Madagascar and West Indian islands. Tenrecs belong to a family of insectivores, Tenrecidae, related to shrews, moles and hedgehogs, but quite distinct from them. Twenty-seven species of three types of tenrecs make up this family--spiny, furred and otter-shrews (Garbutt 1999). They range in size from the Common Tenrec (*Tenrec ecaudatus*), which resembles the European Hedgehog and weighs more than 5 pounds, to the shrew-like tenrecs, *Microgale* genus, weighing less than 2 ounces (Nowak 1999). Tenrecs have some very unusual physical characteristics placing them far from any close mammalian relative. They have variable body temperatures that change with the ambient temperature and, an even more reptilian or avian trait, a cloaca that combines urinal, rectal and generative canals into one (Garbutt 1999).

A striking tenrec is the Lowland Streaked Tenrec (*Hemicentetes semispinosus*). It and a similar species, the Highland Streaked Tenrec (*Hemicentetes nigriceps*), weigh about 5 to 7 ounces and measure some 6 inches in length. White stripes run down their backs like skunks, and barbed, porcupine-like spines are detachable (Eisenberg 1975). The Highland species has a stiff, white neck ruff rising several inches at the back of its head that can be stabbed into the nose of an unwary predator (Eisenberg 1975). Family groups forage together and communicate by vibrating quills that produce low-frequency sounds like dry grass being rubbed together; tenrecs can detect these sounds from distances of more than 4 meters (Garbutt 1999). They also make a number of sounds that are audible to humans.

The Aquatic Tenrec (*Limnogale mergulus*), listed as Endangered in the *2000 IUCN Red List of Threatened Species*, inhabits streams and lakes, living at altitudes between 600 and 2,000 meters (Nowak 1999). This 8-inch tenrec has

clawed, webbed feet, and a long, thin tail for propelling it through the water to feed on small crustaceans and fish. Its habitat in the central highlands has been greatly affected by human disturbance and deforestation. The Aquatic Tenrec has at least one refuge, the new Ranomafana National Park, created for the bamboo lemurs (Preston-Mafham 1991). In 1990, Dr. David Stone managed to lure an Aquatic Tenrec into a live trap, the first one of its kind seen alive in 25 years (Preston-Mafham 1991). Later, four more were taken and studied in captivity for three weeks prior to being returned to the river Namorona in Ranomafana, one of the few clear, unsilted rivers left in Madagascar (Preston-Mafham 1991). This species requires such streams, and only the preservation of forests, such as that in Ranomafana, will ensure its survival.

Another six species in this family, all shrew-tenrecs of the genus *Microgale*, are listed in the *2000 IUCN Red List of Threatened Species*. These tiny insectivores are found in all parts of Madagascar in areas of heavy vegetation, and have dark, soft fur. They range in size from 1.5 to 5 inches in length, and weigh as little as 1.8 ounces (Nowak 1999). Several of the threatened species are highly restricted in range and habitat, and one, *Microgale dryas*, listed as Critical, occurs only in Ambatovaky Special Reserve in the northeastern rainforest (Garbutt 1999).

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Far better known to the world, the lemurs are the focus of many programs to conserve them, as well as research on their wild behavior and biology. New species continue to be discovered; most recently in 2000, three new species of tiny mouse lemurs. Three more have been rediscovered, an indication that other species may yet be discovered to add to the present total of 33 species (Garbutt 1999)**.** This is the only country with five families of primates, making up more than one-third of all primate families; it is home to 12 percent of all primate species and 21 percent of all primate genera (Mittermeier *et al.* 1999). Unlike Brazil, however, which is another center for endemic mammals, Madagascar is far smaller, the size of Kenya, covering 226,656 square miles, or 0.4 percent of Earth's surface (NYT 2000). The number of lemur species is not an indication of their variety since many subspecies differ so radically from one another that in the future, each may be accorded full species status. One species of sifaka, a long-legged kind of lemur, has one subspecies that is pitch black, and another that is pure white. At least 51 species and subspecies of lemurs are known to exist (Mittermeier *et al.* 1999).

The most gregarious of the lemurs are the Ring•tailed Lemurs (*Lemur catta*), who travel about in boisterous, friendly troops, living mainly on the ground. These lemurs have long, fox-like muzzles, large, soft golden-brown eyes, fluffy, gray fur, and black-and-white striped tails. Their body length is 15 to 17 inches, but their rope-like tails are half-again as long, from 21 to 24 inches (Nowak 1999). These 5-pound primates use their boldly patterned tails in a complex language of mutual visual and scent signals. They wave them about to show dominance, as a signal to follow other group members, or rub them on their wrist glands to wave at their rivals in territorial battles (Sleeper 1997). Moving about in troops of up to 25 individuals, they walk rapidly on the ground with the tail held high, waving it about. They wrap their tails around themselves for warmth on chilly nights. Extremely affectionate and playful, their core group is dominated by females (Jolly 1988).

In reserves where they are strictly protected, Ring-tailed Lemurs become very tame, napping on the ground in piles of leaves near tourists. Sometimes they sprawl out on their backs with arms spread wide apart. Females usually have a single young, but when twins are born, one may be "adopted" by a non-pregnant female, who may begin to produce milk in response to her surrogate role (Preston-Mafham 1991). Aunts also help in raising the young, and the daughter born the previous year babysits (Jolly 1988). Lemur babies are a source of great interest to the entire troop, females gathering around the mother and her young, grooming one another and the babies, forming a "grooming pod" (Preston-Mafham 1991). Only half of the infants survive their first year, and only 30 percent reach adulthood (Garbutt 1999). "A Lemur's Tale," shown on PBS in 1996, is a touching film about the death of a young Ring-tailed Lemur. Some fall from high branches, are killed by small carnivores or hawks, die of undiagnosed illness or starve in years of

drought in their arid habitat. Ring-tailed Lemurs communicate with one another in a variety of sounds, from soft mewing contact calls to a territorial "bark-howl." Sometimes chasing and cuffing other members of their group, they are mainly peaceful, spending many hours a day in mutual grooming and in "snoozing-huddles," in which several animals form a complicated embrace from which tails and feet stick out in all directions (Preston-Mafham 1991).

In recent years, Ring•tailed Lemurs have been classified "high priority" for conservation by the IUCN and the Species Survival Commission (SSC) Primate Specialist Group because their habitat of dry woodlands in southern Madagascar is disappearing at an alarming rate due to fires, overgrazing by livestock and tree cutting; they are also hunted with dogs in some areas, and captured as pets (Mittermeier *et al.* 1992, Garbutt 1999). Their distribution has become increasingly patchy as forests are cut (Garbutt 1999). The *2000 IUCN Red List of Threatened Species* lists the Ring-tailed Lemur as Vulnerable, or declining toward endangered status.

One of the strangest mammals in the world is the Aye•aye (*Daubentonia madagascariensis*), so unique that it is assigned to its own family, Daubentoniidae. When first discovered, scientists classified it as a squirrel because of its long, bushy tail and short•legged body. In 1863, however, after anatomical studies, the Aye•aye was revealed to be a lemur, in spite of incisor teeth that never stop growing, long, clawed fingers and other unlemur•like characteristics. Aye-ayes have a perpetually startled expression: huge, round protruding eyes dominate the face, the pupils completely surrounded by deep golden irises. Dark rings surround their eyes, heightening the eerie appearance. The rest of the face and body are gray to black, with long grizzled guard hairs. Spending the day in their twig and leaf nests, Aye-ayes emerge at night to forage for insects and fruit (Garbutt 1999). The Aye-aye's enormous ears are sensitive to the movements of insects under tree bark. At Duke University Primate Center, which has the world's largest number of captive lemurs, Aye•ayes have been filmed using their middle finger, which is twice the length of the other fingers, and skeletally thin, to tap on wood, listening for the movement of insects under the bark. When presented with a block of wood containing insect larvae in holes, the Aye•aye taps the wood and, cocking its head, can tell, even in the case of a hidden hole, the location of the insects, which it then extracts almost surgically, with its middle finger. This primate fills the ecological role of a woodpecker. Aye•ayes eat fruit as well, biting holes into the hard shells of coconuts and scraping the meat out with their middle fingers (Petter 1965). They have also been seen eating nuts of a native tree, nectar from the Traveller's Tree, fungus and lychee nuts (Garbutt 1999).

Aye-ayes have been heavily persecuted by the Malagasy, who consider them to be the embodiment of evil. In general, they are killed whenever seen. Dr. Ian Tattersall once found a dead Aye•aye with a wire pulled tight around its neck (McNulty 1975). In 1990, apparently to dispel the bad luck caused by its having entered a village, local people set an Aye•aye tail on a pole next to the road (Simons 1993). At one time, Aye-ayes were considered among the most endangered animals in the world, facing imminent extinction. To prevent their extinction, a few were captured and released on Nosy Mangabe, a small islet off the northeast coast. Fortunately, Aye•ayes survived on the main island, perhaps because coconut plantations provided food when their forests were cut. Feeding at night, they remained undetected until recently. The Malagasy continue to persecute them.

Since the early 1980s, field surveys have revealed that Aye-ayes have a larger distribution than was originally thought. In 1991, they were seen for the first time in western Madagascar in the northern mountains (Simons 1993). With confirmed sightings in many eastern and northern forests and a few western localities, Aye-ayes inhabit a variety of forest types (Garbutt 1999). They can survive in secondary forest, coming out of their stick nests only at night. And while once thought solitary, groups of three to four individuals have been seen traveling together and feeding at foraging sites (Garbutt 1999). In spite of the greater distribution, the Aye-aye is an endangered species and almost certainly is declining (Garbutt 1999). Aye-ayes require large tracts of forest to maintain viable populations and to protect them from the persecution that often results in their deaths (Garbutt 1999). Although very rare in captivity, several captive births have occurred in recent years at the Duke University Primate Center and Jersey Wildlife Preservation Society zoo in England.

One lemur has recently been rediscovered in the wild and, in the process, an entirely new species was found. The Greater Bamboo Lemur (*Hapalemur simus*) seemed to have disappeared in the wild some time in the mid-19th

century. Not until 1964 was this 5-pound, grizzled, gray-olive lemur seen again in a village market, where it was purchased by a French scientist. Unfortunately, it escaped. A pair captured in 1972 in a southeastern rainforest lived in the zoo in Madagascar's capital city, Antananarivo, until both male and female and their two offspring died (Quammen 1996).

Patricia Wright, an American primatologist, decided to search for this species in 1986 in its supposed range. Fossil evidence indicates that 1,000 years ago, the Greater Bamboo Lemur was widely distributed throughout most of Madagascar's forests, and European naturalists saw it fairly regularly in the 19th century. When she saw a russet-colored lemur clinging to a trunk, making loud "tonking" calls, Wright assumed that she had rediscovered the Greater Bamboo Lemur. Although a different color, she concluded that these animals probably represented a color variation (Quammen 1996). A German primatologist, Bernhard Meier, made independent studies in this patch of rainforest at the same time, also discovering the reddish-gold lemur. Both scientists had great difficulty making observations because of its extreme shyness (Quammen 1996). Finally one was caught, and in 1987, after chromosomal and anatomical studies were done in France, this lemur was found to be an entirely new species (Jolly 1988). It was named the Golden Bamboo Lemur (*Hapalemur aureus*) in a joint zoological paper by Meier, Wright and three other biologists (Preston-Mafham 1991). After months of unsuccessful attempts, Wright took the first photographs of the Golden Bamboo Lemur in the wild. Its beautiful golden-red face mask and belly contrast with darker brown fur on the rest of its body. (See color photographs in Garbutt 1999, Jolly 1988 and Preston-Mafham 1991). This lemur has been found at another location further north, and it is not known whether these populations are isolated from one another. Its population is apparently very low, as only about 1,000 animals have been estimated in the original location of discovery, and its habitat continues to be cleared (Garbutt 1999). The *2000 IUCN Red List of Threatened Species* has classified the Golden Bamboo Lemur as Critical, the most endangered category. Its limited range places it in great jeopardy, and it has been hunted with slingshots; its long-term survival is not secure (Garbutt 1999).

The Greater Bamboo Lemur, the animal first sought, was later found in the same forest, resembling original descriptions and clearly a separate species from the Golden Bamboo Lemur; a third species of bamboo lemur, the Gray Bamboo Lemur (*Hapalemur griseus*), weighs only 2 pounds. It has smoky gray fur and golden eyes, and lives alongside the latter two species in this same forest. This lemur lives in other parts of Madagascar as well (Preston-Mafham 1991).

Each of these three bamboo lemurs eats different parts or species of bamboo plants. One eats the leaves, another the pith, and the third confines itself to new shoots, leaf bases and pith from narrow stems (Quammen 1996). Amazingly, chemical analyses of the plants eaten by the Golden Bamboo Lemur found them to have high concentrations of cyanide, a chemical usually toxic to mammals. Golden Bamboo Lemurs weigh only about 2.2 pounds, and Wright and her co-workers found that, based on toxicity tests of other mammals, they eat 12 times the amount of cyanide that should kill them (Quammen 1996). This is another example of the biological mysteries of Madagascan wildlife.

The Ranomafana forest, with its rare and endemic lemurs and other unusual fauna and flora, would likely have been cut by the Malagasy for more farmland, but Wright spent five years in a successful effort to protect it in the newly•created Ranomafana National Park (Bohlen 1993, Mittermeier *et al.* 1992). This new park covers 108,000 acres of old-growth eastern lowland rainforest. Giant rosewood and other ancient trees tower above a lush understory. It is an extremely important--perhaps the most important--forest for lemurs. Fourteen species of lemurs and 18 other endemic species of mammals live in the park (Jolly 1988). Local people cooperated fully in setting the park™s boundaries, aware of the importance of saving forests. They had experienced a major catastrophe when a cyclone caused landslides, burying entire families in their homes, all precipitated by deforestation (Jolly 1988). In spite of these remarkable achievements, some tree cutting still occurs in Ranomafana National Park (Garbutt 1999).

Wright has continued to study lemurs, now specializing in the exquisite Diademed Sifaka (*Propithecus diadema*) (Brody 1998). Sifakas are the most acrobatic lemurs, leaping from tree to tree, but they have a unique means of locomotion to cross open spaces between trees. Standing on their long hind legs in an upright posture, they hop

sideways, with their arms raised high above their heads. Sifakas can move very quickly in this amazing, dance-like gait, covering distances of more than 100 yards. They are also able to leap vertically to tree branches from a standing position, even carrying babies on their backs. One of their spectacular leaps, some 30 feet up, is the equivalent of a person jumping to the top of a telephone pole. The Golden-crowned or Tattersall's Sifaka (*Propithecus tattersalli*) is a beautiful, nearly all•white species with rich yellow-orange on the crown and tinges of this color on its back, legs and chest. Orange eyes contrast with a furless black face. The smallest of the sifakas, it is confined to a tiny area of only about 15 square miles of forest fragments in northeast Madagascar. The Golden-crowned Sifaka's small population of fewer than 8,000 animals, fragmented into isolated populations, is threatened by forest cutting, brush fires, loss of habitat to agriculture and hunting (Garbutt 1999). Distributed in discontinuous patches of forest, these sifakas may become inbred if corridors are not acquired to link populations. A core part of their forest had been scheduled for cutting for charcoal when scientists named these sifakas. The PBS Nature program, fiMadagascar. Island of Ghosts,fl was the first to film these delicate lemurs (see Video section, Regional - Africa and Indian Ocean Islands). They move about in small groups and feed on a variety of unripe fruits, seeds, shoots, leaves, bark and flowers (Garbutt 1999). No reserve has been set aside for this highly endangered sifaka, although a three-parcel national park covering 20,000 hectares (49,420 acres) has been proposed to protect this species from extinction (Garbutt 1999). The IUCN classifies this species as Critical (Hilton-Taylor 2000).

Although many Malagasy have become far more aware of the need to protect lemurs, some do not understand their rarity or the importance of conserving them. Many rural people still hunt them for food or kill them because of superstitious beliefs. In some areas, the Malagasy try to sell lemurs to foreign scientists. Visiting zoologists studying lemurs have been approached by Malagasy holding captive, and usually injured or dying lemurs, in hopes of a reward. On one occasion, an endangered species of sifaka was brought to primatologist Dr. Alison Jolly, dragged half•choked by a vine around its neck, with one arm dangling loose below the elbow, a jagged bone protruding; blood oozed down its white fur, and it gasped for air through a muzzle smashed by a flung stone (Jolly 1980). Jolly expressed horror at its condition and refused to pay them any reward. She then amazed them by telling them it was a unique sifaka, found only in that small part of Madagascar. They were incredulous . . . not in Antananarivo? . . . Not in France? . . . Not in America? (Jolly 1980). For the majority of people, lemurs are familiar animals, easy to capture and valuable as food. Malagasy schools, established by the French colonial government, taught them only about European animals, encouraging people to assume that their lemurs were unimportant. Fortunately, many Malagasy are becoming concerned about protecting lemurs, and conservation education is taught in an increasing number of schools.

Some lemurs have bred in captivity in zoos and breeding centers, but most, like the endangered Indri (*Indri indri*), have never survived in captivity long enough to breed. In their rainforests, they perch high up, clinging to tree trunks to feed, and suddenly leaping vertically to a neighboring tree, pushing off with their extremely muscular, long legs. Panda-like fur of contrasting black and white--black faces and bodies and white arms and legs--gives them a dramatic appearance. Nearly tailless and heavy--but graceful--their eerie songs, sung at dawn and sometimes during the day, form a loud chorus of high-pitched voices that carries for long distances. Indris were once very common in the eastern rainforest, but much of their habitat has been burned away, making them extremely sensitive to the danger of fires. When a 1992 fire threatened a group in a reserve, they raised such a loud cry that the guards were alerted. They rushed to the scene and put out the fire (Rajaonson 1993).

Although originally found in the far north and central highlands, the Indri is now limited to a narrow strip encompassing only half the rainforests on the island (Garbutt 1999). Indris do not reach sexual maturity until between 7 and 9 years of age, and females are thought to give birth only every second or third year (Garbutt 1999). With such a low reproductive rate, they have been very vulnerable to habitat loss and hunting, especially by immigrants (Garbutt 1999). Moving about in small family groups, they are conspicuous to hunters. The Indri is one of the few lemurs whose killing is considered taboo by the Malagasy, but the old taboos are breaking down, resulting in capture and killing. In some cases, religious leaders encourage such killing. A lemur scientist met a Catholic priest who killed several Indris, roasted them and served them to his congregation, as recorded by Faith McNulty in 1975, and this killing has not ceased. In *Mammals of Madagascar* (Garbutt 1999), two terrified Indris were photographed clinging to poles in a hut, awaiting slaughter for food.

In contrast to the Indri, mouse lemurs (*Microcebus* spp) are so small that it is hard to think of them as primates. The tiniest is the newly discovered Pygmy Mouse Lemur (*Microcebus myoxinus*), with an average weight of only 30 grams, or 1.05 ounces, smaller than any other primate (Garbutt 1999). This tiny mammal is 2.73 inches long, with a tail just under 6 inches in length (Garbutt 1999). The other species are slightly larger, with body lengths ranging up to about 5 inches, and tails of equal or greater length (Garbutt 1999). These nocturnal lemurs have huge dark eyes and are agile and active, resembling African bushbabies. They feed on insects, spiders, and even small frogs and lizards, as well as fruit, flowers and nectar (Nowak 1999). Females form groups and sleep in a nest together with up to nine individuals, while males usually nest alone or in pairs; occasionally males are found in a group of females (Nowak 1999).

A key to protecting lemurs and their forest homes is educating the people of Madagascar about them. The Jersey Wildlife Preservation Trust has put up posters with pictures of lemurs and their protected status around the island. Habitat protection is obviously key to conserving lemurs, and another recent development is the protection of the largest remaining area of rainforest in Madagascar. The Masoala Peninsula in the northeast is the sole home of the Red Ruffed Lemur (*Varecia variegata rubra*), a 9-pound, reddish subspecies of the Ruffed Lemur, but bearing little resemblance to the latter black-and-white species. With $3 million from USAID (United States Agency for International Development) and three years of planning, the new Masoala National Park, covering 210,000 hectares (518,910 acres or 840 square miles), was announced in June 1996 (Terry 1996). This immense park was formally signed into law on October 18, 1997 (Kremen 1998). Thai and Indonesian timber companies had hoped to log these virgin rainforests, but this new law will prevent clearcutting and slash-and-burn agriculture that would have destroyed the forest within less than 50 years. A coalition of organizations helped establish this park, including the Wildlife Conservation Society, CARE and the Peregrine Fund (Garbutt 1999). It will prevent the extinction of the endangered Red Ruffed Lemur, as well as that of the newly rediscovered Madagascar Serpent Eagle (*Eutriorchis astur*) (see below).

In 1997, five Ruffed Lemurs born and raised in the Duke University Primate Center in North Carolina were released in the Betampona Reserve in the northeast to bolster a small, isolated population of this species (Welch 1997). This reintroduction represented a goal in the captive-breeding program at Duke University, which has long planned such a return of these highly endangered primates to the wild. John Cleese, actor and a member of the 1970s British comedy team, Monty Python's Flying Circus, took an interest in the reintroduction program as an enthusiastic lemur admirer. After contributing to the Ruffed Lemur reintroduction program, he wanted to see how they were faring in the wild, and trekked to their remote release site. A delightful film based on this experience, "Lemurs with John Cleese," was shown on PBS in 1999. These Ruffed Lemurs have been released in an area of dense rainforest and rugged hillsides, a long hike from the nearest road. The biologists and assistants who take part in this reintroduction program show their dedication by living for long periods under extremely primitive conditions. Cleese managed to inject humor into this otherwise arduous situation.

At least six species of lemurs, and perhaps more, serve the ecologically important role of pollinating flowers. Many of Madagascar's plants produce unusually large flowers with strong odors and copious nectars attracting lemurs to feed on them. Should any of these lemurs become extinct, the plants that they pollinate will likely follow. Lemurs also play an important role in dispersing seeds. Research by the German Primate Centre at Hamburg University has found that Brown Lemurs are crucial to the regeneration of the western dry forests. About 10 percent of the island's tree species rely largely or entirely on this species to disperse seeds, which pass through their digestive systems.

The surviving lemurs are in extreme danger of following their relatives into extinction. Conservation organizations accord them extremely high priority among endangered primates, and they are the focus of many programs to preserve them. Twenty-nine of the 33 species are listed in the *2000 IUCN Red List of Threatened Species*, all but seven in higher categories of threat. This is an increase of nine species in the four years since the previous edition of the *IUCN Red List* was published (Baillie and Groombridge 1996). Three species and several more subspecies are in the Critical category of species on the verge of extinction, while seven are Endangered, an increase of four species since 1996. All

lemurs are listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the category prohibiting commercial trade, and as Endangered on the U.S. Endangered Species Act.

Although lemurs are protected by Madagascan law, hunting is a major cause of mortality. High fines and even jail sentences may be imposed for killing a lemur, but the severity of the penalties might make officials reluctant to enforce the laws (Peterson 1989). Blowguns, snares, traps, sharpened sticks, slings, stones, guns or even clubs are used to kill them (Peterson 1989). To kill small species of nocturnal lemurs, trees are sometimes cut down, and hunters seize them from their nest holes (Peterson 1989). In the late 1980s, a "sport" hunter bragged of killing 12 highly endangered Verreaux's Sifakas in one afternoon (Peterson 1989). In spite of education programs launched in the 1990s urging the Malagasy to protect lemurs, and the rise in tourists who come to see them, which provides revenues, few have benefited from tourism. Hunting remains a major threat (Garbutt 1999). The rise in human population has resulted in an increased demand for food, particularly protein, far more than the ailing agricultural system can supply (Garbutt 1999). The larger lemur species are especially affected. Because laws against killing lemurs are not enforced, much more education is needed about their potential value in attracting tourism and research funds that provide new jobs. Already tourism has raised income levels among some Malagasy, but hunger is still widespread (Tyson 2000).

In the late 1980s, a World Bank official studying the extreme and worsening poverty on the island said that there might come a time when the people of the capital city would scale the walls of the city zoo and eat the lemurs: "On the downward spiral, animals are at the bottom" (Peterson 1989). Such a tragedy is not inconceivable considering that hunger and poverty have deepened in the decade since. Conservation programs must involve communities while providing an incentive to conserve lemurs. Otherwise, it may be impossible to persuade the Malagasy not to slaughter them.

Although the status of lemurs is deteriorating along with their forests, much is being done to prevent their extinction. The past two decades have been of critical importance to lemur conservation. These extraordinary animals are receiving worldwide attention, and habitat protection for some species has been achieved. Not too long ago, their extinctions seemed inevitable and imminent. Conservation education programs, including showing slides of lemurs and other wildlife to rural children, have been launched. Wright helped to finance the building of new schools and the renovation of existing schools near Ranomafana National Park (Tyson 2000). A number of international organizations are integrating lemur and biodiversity studies with the economic development of entire communities (Garbutt 1999).

For a growing number of Malagasy, learning how special their lemurs are has made lemurs a source of pride and an important national treasure. In the future, Malagasy children may learn from an early age about lemurs and want to protect them. A few decades ago, few films had been made of these fascinating primates, while today many films show their habitats, biology and conservation work on their behalf. One is fiSpirits of the Forest,fl a charming film about many species of lemurs. Others are listed in the Video Section • Mammals. Films of lemurs and the island's environment would provide new insights about these animals if shown to the Malagasy people. Lemurs have also been prominently featured in *Madagascar: A Natural History*, by Ken Preston-Mafham, a beautiful and informative book, and the first guide book, *Mammals of Madagascar*, which provides color photos of nearly every species and subspecies, as well as information on habitats, conservation and status (Garbutt 1999).

In some areas of Madagascar, notably on Nosy Be island, lemurs are fully protected by taboo respected by the Malagasy. Here, beautiful Black Lemurs are fed by the villagers and tourists. This island is being developed intensively for tourism, and the strict nature reserve may be made into a national park (Tyson 2000). This will have mixed results, with new income flowing to the local people from park fees--one of the few countries where this occurs--yet with habitat lost and wildlife disturbed as a result of new hotels and a crush of visitors (Tyson 2000).

The gentle, curious gazes and charming behavior of lemurs have left an indelible impression on many people, and their extinction would be tragic, not just for biological reasons, but also because of their unique and delightful qualities.

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Bats, which perform vital ecological roles in controlling insect populations and pollinating plants, tend to be ignored and often persecuted. Madagascar is no exception. Fifteen species of the 29 species of bats are endemic, living nowhere else (Garbutt 1999). The remaining 14 species live in mainland Africa as well. Fourteen species, or almost half the native bats, are listed by the *2000 IUCN Red List of Threatened Species*. The Yellow Bat (*Scotophilus borbonicus*), the most endangered, is listed as Critical (Hilton-Taylor 2000). This bat has been seen in both eastern and western regions but is extremely rare. A Vulnerable species, the Sucker-footed Bat (*Myzopoda aurita*), is the sole member of its family, Myzopodidae, and an extremely unusual bat. It is able to walk up tree leaves using sucker disks at the bend of its wings and on its feet to adhere to the slippery leaves (Jolly 1988). Only 2 inches long, with a forearm length of 1.9 inches, this tiny bat occurred in East Africa during the Pleistocene, but at present, it is found only in several locations in the eastern rainforest region of Madagascar (Garbutt 1999). It roosts in the Traveller™s Tree. It possesses a complex echolocation system and emits very long calls used to hunt insects (Garbutt 1999).

The largest bat, the endemic Madagascar Flying Fox (*Pteropus rufus*), has a 4-foot wing-span. An extremely colorful bat, its crown and nape are yellowish, and its upper chest and shoulders are rufous to golden brown (Garbutt 1999). It feeds on fruit juices by squeezing pieces of fruit pulp in its mouth, swallowing the juice and very soft fruit pulp, especially of figs, papayas, lychees and guavas (Garbutt 1999). Colonies of these bats roost in tall trees in primary forests or plantations (Garbutt 1999). One large roost at the Berenty reserve has decreased, apparently because of daytime disturbance by tourists who come to see them hanging upside down in the tamarind trees (Preston-Mafham 1991). Elsewhere on Madagascar, the species has declined precipitously from hunting for its meat; only on inaccessible offshore islands do these bats survive without persecution (Preston-Mafham 1991). Of Asian origin, this species is related to fruit bats in the Mascarene Islands. Through captive studies, flying foxes have been found to be extremely devoted to one another (see discussion of Rodrigues Flying Fox in Chapter One).

The Biological Wealth of an Impoverished Country: Mammals: Page 4
The Viverrid family is represented in Madagascar by mongooses, civets, and related carnivores that have evolved into eight species of three endemic subfamilies (Preston-Mafham 1991). Their ancestor is thought to have originated in Africa, and may have colonized the island at an early period. The largest carnivore on the island is the Fossa, or Fosa (*Cryptoprocta ferox*). A zoological oddity, it resembles the Jaguarundi, a neotropical cat, but most authorities place it either in the Viverrid family with civets (Preston-Mafham 1991) or the Herpestidae family with mongoose (Nowak 1999). The only member of its genus, it walks flat on its feet, rather than on its toes like cats (Nowak 1999). Sleek and slender, with golden reddish-brown fur, it has a small head with a blunt, dog-like muzzle, and an extremely long tail. Males weigh up to 22 pounds, with a body length of 2.6 feet and a tail of equal length, while the smaller females measure 2.3 feet and weigh about 15 pounds (Garbutt 1999). It has scent glands which discharge a strong odor when the animal is irritated (Nowak 1999). Widespread but rare in forests throughout the island, this nocturnal predator kills small lemurs, rodents and tenrecs, as well as birds, reptiles, amphibians, invertebrates and, reputedly, domestic chickens (Garbutt 1999). The Fossa often excavates animals from their burrows and can pursue fleeing prey by climbing up trees (Nowak 1999).

The first research study of the Fossa is being conducted by zoologist Luke Dollar, funded by the Earthwatch Institute. Helped by volunteers, he is radio-tracking several Fossa to determine their movements, habits and territory size. As the largest predator on the island, the Fossa plays an extremely important role in the evolution, behavior and population dynamics of lemurs and other prey animals. During the research project, several Fossa have shown

extreme confidence by raiding the tents of the researchers when unoccupied, ransacking them and even chewing metal objects, leather boots, rucksacks, soap and bottles of malaria tablets (Garbutt 1999). For centuries, Fossas have been persecuted by the Malagasy, believing them to be ferocious and evil.

The Fossa gives birth to a litter of two to four young, which mature very slowly and may not be fully independent until they are about 4 years old (Garbutt 1999). This slow rate of reproduction has made the Fossa vulnerable to extinction. Along with losses from killing by the Malagasy, its forest home has been steadily whittled away by slash-and-burn agriculture. The Fossa is listed as Endangered in the *2000 IUCN Red List of Threatened Species*, a higher category of threat than it received in the 1996 version of this list.

Gerald Durrell, renowned author and conservationist, traveled in the western forests to capture Aye-ayes for captive breeding. He encountered a Fossa venturing out during the day--an unusual behavior: "A flash of russet red caught my eye in the bushes some six feet in front of the vehicle and, suddenly, from out of the undergrowth, silent as a cloud shadow, came a Fossa which walked languidly to the middle of the road and sat down" (Durrell 1993). Remaining there, the Fossa proceeded to groom himself, apparently unaware of Durrell's presence. Then, with a sigh and a wide yawn, the Fossa crossed the road and disappeared into the forest, "his immense sickle of a tail swinging from side to side like a bellrope behind him. To have spent ten minutes with such a rare and beautiful creature was a privilege" (Durrell 1993).

The Falanouc (*Eupleres goudotii*), sole member of its genus and a viverrid, is the size of a domestic cat. It has dense, woolly fur and an extremely pointed and narrow muzzle. Native to humid eastern lowland forests and marsh areas and portions of the northwest, Falanoucs are active at twilight and during the night. Feeding mainly on earthworms and other invertebrates, they use their long snouts and tiny, conical teeth to catch prey in leaf litter (Garbutt 1999). The species is rare or extremely rare over most of its range and is classified as Endangered by the IUCN (Hilton-Taylor 2000). Like the Fossa, it has declined as a result of deforestation, drainage of marshes, hunting by the Malagasy, attacks by feral domestic dogs, and possibly competition with the introduced Small Indian Civet (*Viverricula indica*).

The Malagasy Civet or Fanaloka has the scientific name *Fossa fossana*, which has been confused with the Fossa. Like the Fossa and Falanouc, it is the only member of its genus. Looking more like spotted civets from mainland Africa and Asia, this reddish 3-pound carnivore has rows of black spots on its back, merging into stripes toward its bushy, grayish tail. Its distribution is far more restricted than the Fossa's or the Falanouc's, being confined to eastern rainforests which have been reduced to less than 10 percent of their original size. Sheltering in tree holes or crevices, the Malagasy Civet lives in pairs and feeds on crustaceans, worms, small eels and frogs (Nowak 1999). A pair has a single young, and a captive civet lived 11 years. Hunting and trapping have also threatened the Malagasy Civet, which is listed as Vulnerable by the IUCN (Hilton-Taylor 2000).

Five other viverrids, all mongooses, are native to Madagascar, and all are threatened with extinction from a loss of forest habitat and persecution. A few have very restricted distributions. They tend to be secretive unless in a secure forest reserve, and little attention has been paid to their conservation, biology or habitat requirements. Several are uniform brown or russet, while two have bold black dorsal stripes ending in white, bushy tails. One, the Brown-tailed Mongoose (*Salanoia concolor*), is native to the northeast rainforests, but almost nothing is known of this small carnivore (Garbutt 1999). All of the eight native civets, mongooses and related animals are listed as Vulnerable or Endangered by the *2000 IUCN Red List of Threatened Species*.

The Biological Wealth of an Impoverished Country: Mammals: Page 5
Among Madagascar's 11 species of murid rodents are several extremely bizarre forms. The largest is the Giant Jumping Rat (*Hypogeomys antimena*), the size of a rabbit and weighing 2 pounds, 10 ounces (Preston-Mafham 1991).

Restricted to a small area in western dry, deciduous forests north of Morondava, in west-central Madagascar, its entire range is thought to encompass only 39 square miles (Preston-Mafham 1991). Once far more widely distributed, remains have been found in southwest and central Madagascar (Garbutt 1999). These huge rodents search for food, such as fallen fruit, on the forest floor and feed by sitting on their hindquarters and holding food in their forepaws like a rabbit (Garbutt 1999). Giant Jumping Rats build deep burrows and, unlike the vast majority of rodents, a mated pair maintains long bonds with one another and with their young (Garbutt 1999). Male young leave after one year, and females stay with both parents for two to three years (Garbutt 1999). Only one or two young are born in a litter, and predation by Fossa and the Madagascar Ground Boa (*Acrantophis madagascariensis*) is high (Garbutt 1999). With no reserve and a habitat that continues to decline, this huge-eared rodent is in danger of extinction. A reserve is planned for this species, which is listed as Endangered by the *2000 IUCN Red List of Threatened Species*. fiMadagascar. Island of Ghostsfl filmed the Giant Jumping Rat in the wild, one of the only videos of this fast-disappearing species (see Video section).

Eight of Madagascar's native rodents, or 73 percent, are listed by the IUCN in various categories of threat. Two are considered Critical: the Madagascar Mouse (*Macrotarsomys ingens*) and the Madagascar Rat (*Eliurus penicillatus*). The mouse is known only from a single area in northwestern Madagascar, in dry deciduous forests where the type specimen was found, and it is thought to be almost totally arboreal and nocturnal (Garbutt 1999). The Madagascar Rat has not been seen since the type specimen was collected in central-eastern montane rainforest.

The Biological Wealth of an Impoverished Country: Birds

The Biological Wealth of an Impoverished Country: Birds: Page 1

Until recently, the amazing lemurs and other mammals of Madagascar eclipsed its remarkable bird life. Apart from the extinct elephant birds, 120 species of the 204 native birds are unique to the island (Morris and Hawkins 1998). Like tropical birds of other parts of the world, most are dazzlingly beautiful in brilliant hues. Unlike most tropical birds, however, they represent fascinating examples of evolution, including families of birds that exist nowhere else, having evolved from a single ancestor into many forms, some very bizarre. Most ornithologists recognize five bird families as unique to Madagascar, each with extremely distinctive characteristics. Four of these have some or all species that are threatened. The fifth, a family consisting of a single bird, the Cuckoo-Roller (*Leptosomus discolor*), is secure for the moment (Morris and Hawkins 1998). A few thousand years ago, there may have been far more native bird species that disappeared without a trace as their habitats were destroyed.

Native birds are not thriving, as people and livestock destroy their varied habitats, to which they had adapted over thousands of years. A total of 41 species, all but three of which are endemic, have been listed in the *2000 IUCN Red List of Threatened Species*, based on the research of BirdLife International published in 2000 in *Threatened Birds of the World*. The latter book illustrates each threatened Madagascan bird and describes status, population numbers, distribution and other pertinent information. The three non-endemic birds also breed in the neighboring Comoros or Seychelles (BI 2000). Thus, 20 percent of all native birds and 34 percent of endemic birds are threatened, five species listed as Critical, six as Endangered, 16 as Vulnerable, and 14 as Near-Threatened (BI 2000). Moreover, many native birds that were once widespread have become restricted to isolated forest reserves and parks, not yet endangered but

far less numerous than in previous times. While the percentage of threatened birds is less than that of endemic mammals, it is significant, especially considering that 27 species are either Critical, Endangered or Vulnerable in the *2000 IUCN Red List of Threatened Species*. Madagascar has more threatened birds that all of the continental United States (excluding Puerto Rico and Hawaii). Its threatened birds total 41 threatened species, five greater than the United States™ 36 (BI 2000). Only 4 percent of the 810 breeding birds native to continental US and Canada combined (Sibley 2000) are threatened. If birds in the United States faced the same degree of threat as Madagascar's birds, at least 162 species would be threatened with extinction.

Fortunately for the future of these unique birds, organizations such as BirdLife International; the Peregrine Fund; Conservation International; the Jersey Wildlife Preservation Trust; and an ad hoc group, The Working Group on Birds in the Madagascar Region, are researching and working to conserve Madagascar's native birds. Malagasy ornithologists and members of the public are participating in surveys, studies and conservation programs. An inventory of the status and taxonomy of all of Madagascar's birds is in progress (Morris and Hawkins 1998).

In spite of Madagascar™s many unusual birds, interesting to specialists and amateur birdwatchers alike, no bird guide or text illustrating and describing the island's avifauna existed until 1990, when Olivier Langrand's *Guide to the Birds of Madagascar* was published, providing information on natural history, status, habitats and distribution, as well as color paintings of all native birds. This material supplemented the lengthy descriptions in *Threatened Birds of Africa and Related Islands*, a 1985 publication of the International Council for Bird Preservation, now called BirdLife International (Collar and Stuart 1985). *Madagascar: A Natural History*, by Ken Preston-Mafham (1991), included extensive information on many native birds and their habitats. *Birds of Madagascar, A Photographic Guide* (Morris and Hawkins 1998), published in 1998, updates the latter publications with vivid color photographs illustrating almost all native birds, including many species discovered or rediscovered during the 1990s, such as the two new species, the Cryptic Warbler (*Cryptosylvicola randrianasoloi*) and the Red-shouldered Vanga (*Calicalicus rufocarpalis*), and the rediscovery of several birds thought extinct: the Madagascar Serpent Eagle, Madagascar Red Owl (*Tyto soumagnei*) and Red-tailed or Fanovana Newtonia (*Newtonia fanovanae*). The 1990s also saw the making of many films about the island's wildlife, including its birds (see Video section).

The Biological Wealth of an Impoverished Country: Birds: Page 2

Birds native to aquatic habitats have declined even more dramatically than many forest birds. The largest lake on Madagascar, Lake Alaotra in the northeast, was once a paradise of waterbirds, turtles, frogs and other wildlife. Traditionally, portions of the lake were used by the Malagasy for rice cultivation, without serious damage to the environment or resident wildlife. But as their populations and food requirements grew, people began to destroy more and more of the natural marsh and reed beds that lined the lake, and cleared the surrounding forest for firewood and agriculture. This destroyed the lake's water quality. With no trees to hold back the soil and conserve water, this once-beautiful lake became heavily silted by runoff (Durrell 1993). Added to this, non-native tilapia fish were introduced into the lake as a food source for the local people. The fish eat vegetation needed by dragonflies and other fauna that form the basis of the lake's food chain (Preston-Mafham 1991). This ecological collapse has greatly reduced rice production on the lake, although reeds are still being cleared for rice growing, fragmenting wildlife habitat (Garbutt 1999).

The effects on native aquatic birds have been catastrophic. Lake Alaotra is the only known habitat of the endemic Alaotra Grebe (*Tachybaptus rufolavatus*), which is presumed extinct (BI 2000, Morris and Hawkins 1998). No sightings have been made since 1985, when only two birds were seen. It declined from loss of its habitat, hunting and hybridizing with the Little Grebe (*Podiceps ruficollis*), a recent arrival from Africa (Morris and Hawkins 1998). Many fruitless searches for the species have been carried out in the lake and surrounding area since then (BI 2000, Morris and Hawkins 1998). This small, black-capped grebe was very sedentary and may have been nearly flightless because

of its extremely short wings.

Another waterbird restricted to Lake Alaotra, the Madagascar Pochard (*Aythya innotata*), is also probably extinct, having been eliminated by the same threats as the Alaotra Grebe (BI 2000). This duck declined steeply from 1930 on, and the last known bird, a male, was captured in August 1991, having been caught in fishing gear. This bird later died, and intensive searches in 1989 and 1990, and again in 1993 and 1994, failed to discover more Madagascar Pochards (BI 2000, Collar *et al.* 1994). A handsome bird, the pochard was chestnut-colored, with dark gray bill and yellow eyes (see photograph in Morris and Hawkins 1998). A shy species, its breeding and behavior were studied, but apparently nothing was done during its precipitous decline to prevent its extinction. Classified as Critical, hope remains that a few birds exist in wetland habitats around Lake Alaotra (Morris and Hawkins 1998).

The Jersey Wildlife Preservation Trust has begun education campaigns in the vicinity of Lake Alaotra to teach local people about the presence of the highly endangered Alaotra Reed Lemur or Bandru (*Hapalemur griseus alaotrensis*), a subspecies of the Grey Bamboo Lemur, and the importance of protecting the reed and papyrus beds. This lemur has been classified as Critical by the IUCN. The only lemur to live in an aquatic environment, the Alaotra Reed Lemur is larger than other subspecies of the Grey Gentle Lemur and lives in close, family groups (Garbutt 1999). To move about in the reed beds, they climb up a reed stem until it bends, and then walk along it to reach the next stem; their major food is the endemic papyrus, along with grasses and ferns (Garbutt 1999). Lake Alaotra's reed beds are its sole habitat, and although previously widespread in this and another lake to the north, only two isolated populations of lemurs, one of which numbers fewer than 60 animals and is on the verge of extinction, remain in marsh fragments (Garbutt 1999). This lemur has the most restricted range of any lemur species or subspecies (Garbutt 1999). The film, fiMadagascar. A World Apart,fl includes a moving segment on these lemurs feeding among the papyrus when a Malagasy canoe enters the marsh and sets a fire, causing the terrified lemurs to flee. (See Video section). Local village leaders have requested that the government set aside a protected zone in the marshes. There is hope that this lake will be brought back as a functioning ecosystem in the future and that a strict sanctuary will be set aside for this endangered lemur and the highly endangered waterbirds.

While sizeable areas of forest have been protected, few aquatic environments on Madagascar have been preserved, and native waterbird species are declining precipitously. The Madagascar Little Grebe (*Tachybaptus pelzelnii*) was once common and widespread in many parts of the island; with the pollution and destruction of marshes throughout the island for rice farms, this bird has declined greatly. The introduced tilapia was threatening this species by consuming its food supply. This grebe also hybridizes with the introduced Little Grebe (Collar *et al.* 1994). The Little Grebe, an African species which has colonized the island, prefers the habitat created by the tilapia, and is now abundant (Langrand 1990). The Madagascar Little Grebe has also drowned in fish nets, and has lost the vegetation it needed for nesting (BI 2000). It is expected to follow the Alaotra Grebe and Madagascar Pochard into extinction.

Another endemic waterbird, the Sakalava Rail (*Amaurornis olivieri*), native to western wetlands, is also extinct or nearly so. A small, sooty-black bird with yellow beak and pinkish-red legs and feet, it was native to streams and marshes in the western parts of the island. For more than 30 years, this species was not seen at all. In 1995, one was glimpsed at Lake Bemamba, and another in 1999 at the same lake (BI 2000). This species is classified as Critical (BI 2000), and Lake Bemamba and other lakes and wetlands on the west coast may be given protection by the Malagasy government, which has ratified the Ramsar Convention on wetlands preservation (BI 2000).

As a result of extensive habitat destruction and hunting, the Madagascar or Bernier's Teal (*Anas bernieri*) has likewise declined to endangered status in the few sites from which it is known on the west coast. Once widespread on the island, it is now restricted to a few marshes and shallow lakes. Small populations remain on Bemamba Lake and a few other sites (Morris and Hawkins 1998), and a flock of 67 was seen in another area (BI 2000). In 1970, 60 of these birds were seen on a lake, and as soon as this became known, European sportsmen went to the lake and killed more than 25 percent of the population (Curry-Lindahl 1972). In the 1970s, Bernier's Teal inhabited Lake Masama, but heavy hunting by both Europeans and natives with dogs has nearly eliminated them (Todd 1979). In 1993, four birds were captured for captive breeding (Collar *et al.* 1994). The Jersey Wildlife Preservation Trust is working to preserve

this beleaguered species and the marshes of the west. The Madagascar Teal has been seen in three protected areas, and a conservation program at one lake has been initiated (BI 2000).

The critically endangered Madagascar Fish Eagle (*Haliaeetus vociferoides*) numbers about 250 pairs in the 600-kilometer stretch of western coastline to which it has become confined (BI 2000). This large eagle resembles the African Fish Eagle, from which it probably evolved, but instead of a snowy white head and upper body, it is streaked with brown and has shaggy, buff crown feathers. About 35 inches long, with a 6.5-foot-wingspan, it is by far the largest bird on Madagascar. Persecuted by local people, these eagles have been shot and their nests destroyed. On one occasion in the 1990s, ornithologists saw some immigrants cut the tree where an active nest of a Madagascar Fish Eagle was located, and proceed to kill and eat the chicks! The only remaining habitat for this species is the western coast, where mangrove swamps are rapidly being destroyed (Langrand 1990, Preston-Mafham 1991). The Peregrine Fund is sponsoring research on this species, and 10 nests have been located in an area on the west coast in the Three Lakes Complex (BI 2000). The Fund has removed and raised chicks that would have been killed by siblings and released them to augment the population. The fish it feeds on are being depleted, however, by a gill-net fishery that has recently been established. A new Malagasy law allows local communities to control their own resources, and the people in this region are being encouraged to formalize conservation regulations prohibiting gill netting and tree cutting.

The Biological Wealth of an Impoverished Country: Birds: Page 3

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The Biological Wealth of an Impoverished Country: Birds: Page 4

As more and more bird-watchers come to Madagascar, the government may place a higher priority on bird conservation. A special fund to which bird-watchers could contribute might be established to purchase and maintain refuges and to conduct conservation education and other projects for local people, especially in aquatic habitats. The preservation of threatened Madagascan birds has reached a critical point. The most endangered habitats, the last of the western forests, aquatic environments, and many parts of the eastern lowland rainforests, continue to decline. The fragmentation of forests that forces animals into islands of isolation needs to be studied and remedied by establishing habitat corridors between them. One Malagasy ornithologist, Aristide Andrianarimisa, is researching the effects of forest fragmentation on birds.

Pete Morris and Frank Hawkins, authors of *Birds of Madagascar. A Photographic Guide*, state that their purpose in writing their book was to inspire people to visit Madagascar and take an interest in its avifauna and the plight of so many threatened birds, as well as to promote greater interest in wildlife and conservation among the Malagasy people. Ecotourists bring revenue to the island and, thereby, help to preserve natural areas and wildlife (Morris and Hawkins 1998). The discovery of a new species of songbird, the Cryptic Warbler, by bird-watchers in Ranomafana National Park, is an exciting byproduct of ecotourism and an indication that the study of Madagascar's birds has just begun. It also proves that amateurs play an important role in bird observation. *Birds of Madagascar* establishes a good precedent by identifying, on a species-by-species basis, the avian habitats and those birds lacking reserves within their ranges. The authors request that people coming to see the wildlife of the island let the government know why they have come in order to convince decision makers that biodiversity conservation represents a worthy investment (Morris and Hawkins 1998).

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians

The distribution and diversity of Madagascar's reptiles and amphibians have not been carefully researched until the present. Chris Raxworthy, a British herpetologist, is in the process of carrying out the first methodical survey of the estimated 500 non-marine species, all of which are endemic (Holmes 1997). To date, at least 300 reptile and about 200 frog species have been identified (Tyson 2000). This would make it one of the top five countries in the world for diversity of reptiles and amphibians. The British Isles, by contrast, with about half the land area of Madagascar, have only six species of reptiles (Preston•Mafham 1991). Even the ranges of newly described lizards and frogs will not be delineated precisely for some time. Some areas remain unexplored by herpetologists, and Raxworthy finds new species of lizards and frogs on each expedition into the tangled swamps and forest fragments. On one day when accompanied by a journalist, he and fellow researchers, including Malagasy biologists, found a bright green day gecko, a strikingly beautiful yellow-and-black snake, tiny frogs resembling lichens, a leaf-tailed gecko and 4-inch chameleons with upper legs the colors of Rainbow Trout, and lower legs like toothpicks (Holmes 1997). In a reserve on Nosy Be island, he and some Earthwatch Institute volunteers rediscovered a 10-inch green lizard that had been lost to science since the 1890s, when last collected (Tyson 2000). Raxworthy is doing inventories in reserves as part of an

island-wide biodiversity program, and hopes that in some impenetrable area, giant tortoises long considered extinct will be rediscovered (Holmes 1997).

Page 1 (Threatened)
Page 2 (Tortoises and Turtles)
Page 3 (Lizards)
Page 4 (Snakes)
Page 5 (Amphibians)

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Of these native reptiles and amphibians, at least 19 are known to be threatened with extinction. A preliminary list includes 17 species of reptiles (four tortoises, a freshwater turtle, four sea turtles, a gecko, four chameleons and three boa snakes) and two amphibians, both frogs. All are in higher categories of threat: Endangered or Vulnerable by the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000). All but the sea turtles are endemic to Madagascar.

The arid regions at the northern and southern ends of Madagascar are home to two intricately patterned tortoises, both in danger of extinction. In the north is a species considered by many to be the world's most endangered tortoise: the 18-inch Madagascar or Plowshare Tortoise (*Geochelone yniphora*), whose tan, domed shell is marked with narrow black lines in delicate hexagonal patterns. The Plowshare name came about because of a protuberance on the tortoise™s lower shell that turns up, a kind of knob that remotely resembles a plowshare. This knob is used by males in sparring contests. From the 17th century onward, thousands of these tortoises, which were once abundant and widespread, were shipped every year to the nearby Comoro Islands to use as meat for settlers, driving the species to the edge of extinction before the trade finally ended in the 19th century (Juvic *et al.* 1981). Their populations never recovered, due to the continued take by villagers for pets and the massive destruction of their habitat. Known to the Malagasy as the "Angonoka," this tortoise was headed for extinction until 1985 when the Jersey Wildlife Preservation Trust was requested by the IUCN to work with the Malagasy government in formulating a rescue plan, Project Angonoka (Reid 1995). Research on the tortoise™s wild status and behavior began immediately, and a captive-breeding program was established at a government forestry station (Reid 1995).

By 1986, eight adult tortoises had been gathered from the wild and placed in an enclosure which had ample vegetation and conditions natural enough that two male Angonokas immediately began their fights of strength (Reid 1995). Gerald Durrell, founder of the Jersey Wildlife Preservation Trust, in his book, *The Aye-aye and I* (1993), described lone males showing no interest in breeding, even if surrounded by females. But when another male is present, they face each other prepared for combat: "The two males, rotund as Tweedledum and Tweedledee dressed for battle, approach each other at what, for a tortoise, is a smart trot. The shells clash together, and then the plowshare comes into use. Each male struggles to get this projection beneath his opponent and overturn him to win a victory in this bloodless duel" (Durrell 1993). Finally, when one is able to overturn his opponent, he lumbers over to mate with the female while the vanquished male "wanders dispiritedly away" (Durrell 1993).

Project Angonoka has shown success both in captive breeding these tortoises, which may number only between 300 and 1,000 in the wild, and in working with local people to conserve remaining wild populations (Durbin *et al.* 1996). In fact, by 1995, a total of 140 captive-bred juveniles, ranging in age from 10 months to 6 years, had been produced at the breeding center. The breeding program was described in an illustrated article entitled "Observations on Hatchling and Juvenile Captive-bred Angonoka in Madagascar," published in the Jersey Wildlife Preservation Trust's annual journal, *The Dodo,* issued early in 1996. Within months, the captive-breeding program was devastated by the theft of 76 animals--two adult females and 74 hatchlings. On May 6, 1996, someone cut through the flimsy chain-link fence and the wire of the enclosure and took half the animals that were the fruit of a decade's work. Not until a female is 20

years old does she begin breeding, so the loss of two breeding females and their hatchlings dealt the program a devastating setback (McNeil 1996a). The burglary may have been an inside job, since the dog on the premises did not bark to alert the personnel who were sleeping close by (Tyson 2000). It is unlikely that these adult females will breed in captivity, as there are almost no adult male Plowshare Tortoises in breeding programs, and without more than one, no breeding occurs.

Animal smugglers care little about the effect of their actions on the survival of endangered species. Reptile collectors will pay thousands of dollars for rare specimens, and this break-in had been planned. A Dutch rare animal dealer had advertised Plowshare hatchlings for sale the month before, at $3,000 apiece, saying they would be "available soon" (McNeil 1996a). Ten of the hatchlings were traced to Prague, where wildlife law enforcement is weak, and others were suspected to be in the Netherlands, where they would be sold to collectors in the United States, Spain, Germany and Japan (McNeil 1996a). The loss of these tortoises cost the breeding program years of work. Don Reid, the Conservation Field Officer in charge of the Plowshare Tortoise captive-breeding program, had experimented for years to achieve a proper diet for the tortoises, arranged male combats, and conducted lengthy experiments to learn proper conditions for the eggs to hatch (Reid 1995). These tortoises became so tame that they would stretch their necks out to be scratched (McNeil 1996a). Although discouraged by the theft, he continued the breeding program; 40 new tortoise hatchlings were produced in late 1996, bringing the total to 130 juveniles. In 1998, several of the smuggled tortoises were seized from a Malaysian animal dealer in Mexico City who had been the subject of a long-term U.S. Fish and Wildlife Service undercover investigation. The same year, three more Plowshare Tortoises were seized in Belgium as they were being imported (TRAFFIC 1999a). The species is listed by the *2000 IUCN Red List of Threatened Species* as Vulnerable, and is protected by the Malagasy government, which bans trade.

Officials from the Jersey Wildlife Preservation Trust and other conservationists have sponsored education programs aimed at informing local people about the tortoises and their rarity. This has resulted in their cooperation in helping to guard wild tortoises from poachers and control brush fires (Durbin *et al.* 1996). This region in northwestern Madagascar has lost most of its forest cover; Arab residents cut trees and burn them to clear the land for agriculture, and feral pigs kill the young wild tortoises (Durbin *et al.* 1996). So much clearance of natural vegetation has taken place that the climate has become increasingly more arid, causing ponds to dry up. Tree cutters are now turning to the mangroves, causing siltation of the inlets, which affects prawn harvests (Durbin *et al.* 1996) and destroys a key aquatic environment on the island.

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians: Page 2

The Plowshare Tortoises have been reduced to a few forest sites, and in spite of the urgent need for a reserve, none has been set aside. The area is getting conservation help with the formation of a new organization by conservation biologists, the Association to Safeguard the Environment. Its purpose is to involve local people in environmental projects, such as planting cashew trees, learning fire suppression methods, and trapping bush pigs; they are also giving conservation lessons to children and conducting literacy classes (Durbin *et al.* 1996).

The Radiated Tortoise (*Geochelone radiata*) inhabits the drylands of the extreme south, where the strange Didierea plants and other desert vegetation grow in open shrubland. Many people consider this tortoise to be the most beautiful in the world. Delicate yellow sunburst patterns adorn the top of its 16-inch-long black shell, and the underside is marked with diamond patterns. These tortoises also declined after tens of thousands were killed to supply local villagers with meat, or exported to the Comoro Islands from the 17th century on for meat markets abroad. In 1922 alone, 22,000 of these tortoises were exported (Jolly 1980). The legal trade did not cease until 1930. The tortoise populations have not rebounded, and illegal capture for collectors and zoos may be the explanation. The slow reproduction of this species means that it cannot quickly make up for losses in its population. An extremely long-lived

species, it has evolved with low natural mortality and has few young. As an example of its longevity, a Radiated Tortoise of unknown age presented to the Queen of Tonga by Captain Cook in the 1770s, lived until 1966, making it almost 190 years old at its death (Jackson 1993).

The lovely patterns on this tortoise's shell, which vary from individual to individual, have placed it in great demand around the world, encouraging poverty-stricken Malagasy to risk jail to earn the money that these tortoises bring. Thousands of Radiated Tortoises have been collected for the international market, sold in Europe, North America and elsewhere for $2,000 or more per animal. In spite of having a range that is far larger than that of the Plowshare Tortoise, the Radiated Tortoise is declining rapidly toward extinction. The species is listed by the *2000 IUCN Red List of Threatened Species* as Vulnerable. Export and collection of Radiated Tortoises are prohibited by the Malagasy government, with severe penalties for violations including prison sentences. The United States lists both the Radiated and Plowshare Tortoises on the Endangered Species Act, which prohibits commercial importation. International commercial trade is banned by their listing on Appendix I of CITES. Still, the smuggling continues, fed by the many wealthy collectors who have no conscience about the effect their purchase has on wild populations, and the zoos that knowingly purchase smuggled animals. Malagasy authorities have failed to put an end to the poaching, especially of the Radiated Tortoise and other southern species.

Donovan Webster, a journalist, researched the rampant smuggling of Radiated Tortoises and other wildlife from the island for *The New York Times Magazine*, which published his lengthy article on February 16, 1997. The magazine cover featured the article and read: "I was caught in Madagascar. Peddled for 30 cents. Smuggled to Orlando. Sold for $10,000. I'm a rare, coveted tortoise--coldblooded contraband." Webster found that Madagascar was a "pirate's paradise," with little or no local enforcement of conservation laws. Its long and unpatrolled coastline is used by smugglers, who load tortoises onto small boats at night, with little fear of arrest (Webster 1997). Although some enforcement of capture bans takes place in the range of the Radiated Tortoise, local people have learned to avoid arrest.

The contrast between the attitudes of local people toward the Plowshare Tortoise in the north, where education programs have been carried out by the Jersey Wildlife Preservation Trust, and the south, where no strong program exists to protect the Radiated Tortoise and other wildlife, could not be more dramatic. In the south, poaching Radiated Tortoises and other reptiles is considered an accepted form of revenue by the extremely poor people of the region. At local bars and restaurants, Webster was approached by people who offered to produce a rare snake within 24 hours. Snakes are a favorite animal for smugglers because they can be secreted in small bags and placed in luggage or, if they are small enough, in pockets. He refused a boa, which was offered at $300 and could be sold for $2,000 in the United States (Webster 1997).

Webster exposed a large-scale and fairly open trade in Radiated Tortoises in local markets within the range of these tortoises. He visited a woman who was reputed to have many of these tortoises for sale. She showed him 24 Radiated Tortoises which she kept ready for sale to anyone who would pay the right price; they were crowded into a make-shift pen in her living room, stacked two and three deep in filthy conditions (Webster 1997). They grunted and made hissing sounds when disturbed, scratching and scrabbling against one another and the pen sides; their shells were covered with dust, and most appeared to be sickly (Webster 1997). The woman tossed the tortoises back into the pile after handling them. She claimed that she sold them to local people for $1.35, and to outsiders for $4 or more, depending on how many tortoises she had at the time (Webster 1997). She also admitted supplying a smuggler who arrived once a week in a canoe at a remote beach with any Radiated Tortoises she had in stock (Webster 1997).

These tortoises are absurdly easy to collect in the wild, living in open shrubland and moving so slowly that they can be picked up as easily as rocks. Webster witnessed the capture of one mature tortoise which Benjamin, one of the collectors, located in the shadow of a boulder. When he approached, the tortoise hissed and tried to crawl beneath bushes, but it was easily grabbed, and he flipped it on its back; soon he caught two other adult tortoises who had a baby the size of a small stone wedged beneath them in an apparent attempt to protect it (Webster 1997). Collectors wrap string around the tortoises™ shells to form handles for carrying them. When they met at the end of the day, they

had taken 54 mature tortoises and many young ones, making it a "banner day" (Webster 1997). The occasional presence of enforcement officers and World Wildlife Fund (WWF) representatives did not seem to present any anxiety of threat of arrest to the collectors (Webster 1997).

Each Radiated Tortoise is worth at least $2,000 once smuggled out of Madagascar, and those with unusually exquisite patterns bring as much as $10,000 (Webster 1997). Benjamin later admitted that he was aware that the tortoises were becoming rarer and that their range had shrunk in recent years; he also knew that many were very old, probably older than his own 53 years. It was obvious that the tortoises would soon be gone, but he believed this was his only potential income source; he was uncertain about how he would make a living when there were no more Radiated Tortoises (Webster 1997).

Some of the smuggled Radiated Tortoises leaving Madagascar have been seized by importing countries. In May 1992, for example, a Dutch citizen arriving from Madagascar was stopped by Customs at Roissy Airport in the Netherlands in possession of 46 Radiated Tortoises as well as 14 bamboo lemurs of several species and seven endangered Madagascar Boas (*Acrantophis madagascariensis*); the animals were confiscated and returned to Madagascar (TRAFFIC 1992). In 1998, a Radiated Tortoise was among many rare tortoises seized in Belgium as they were being imported, and U.S. authorities, under fiOperation Chameleon,fl an undercover investigation of trafficking in illegal Madagascar reptiles, seized Radiated Tortoises from an American reptile dealer in Miami. In May 1999, French Customs officers seized 450 tortoises smuggled by three Malagasy citizens living in Paris (TRAFFIC 1999b). Among them were 120 Radiated Tortoises; the suspects were not arrested (TRAFFIC 1999b).

Most ecotourism on the island has been developed for viewing lemurs, chameleons and birds, but the Radiated Tortoise and its extraordinary habitat of endemic plants have the potential of attracting many tourists. Also living in this tortoise's habitat are spectacular sifakas, many unusual birds, and other reptiles. In Beza-Mahafaly Reserve, scientists are studying the ecology and longevity of these tortoises, as well as searching for a permanent form of marking that would make them unattractive to collectors. The Radiated Tortoise could be conserved while helping local people like Benjamin. Grants from international organizations could finance jobs held by local people, such as ex-poachers, to protect the tortoises and serve as wardens. Former collectors could help educate schoolchildren and local people about protecting Radiated Tortoises and other wildlife. Organizations, such as Earthwatch Institute, might sponsor research to study the status of these tortoises. The presence of scientists would pose a deterrent to poachers.

Two other endemic tortoises, the Spider Tortoise (*Pyxis archnoides*) and the highly endangered Flat•shelled Tortoise (*Pyxis planicauda*), are much smaller, about 5 or 6 inches long (Preston•Mafham 1991). The latter tortoise is restricted to a forest of only 40 square miles, and a captive•breeding program is attempting to prevent its extinction. Both these tortoises lay only a single, large egg (Preston•Mafham 1991). These tortoises are also in demand by reptile collectors. In August 1996, six men were indicted after being arrested with four Spider Tortoises in their luggage at the Orlando International Airport in Florida. They were part of a smuggling ring supplying rare reptiles to collectors. In 1999, 330 Spider Tortoises were seized along with Radiated Tortoises in the case cited above (TRAFFIC 1999b).

The Madagascar Big-headed Turtle (*Erymnochelys madagascariensis*), is an endangered freshwater species listed in the *2000 IUCN Red List of Threatened Species* and on Appendix II of CITES. This turtle is related to South American river turtles, another link that may date back to the time before Madagascar drifted away from Gondwana. The Jersey Wildlife Preservation Trust began a breeding program for these turtles in 1999 with the objective of releasing young turtles back into the wild after educating local people.

The Biological Wealth of an Impoverished Country: Reptiles and Amphibians: Page 3
Madagascar is home to two•thirds of the world's chameleons--at least 62 species--more than any other country (Tyson

2000). Among the island's endemic chameleons are the world's smallest and largest species. The smallest, *Brookesia minima*, is only 1.3 inches long, while the largest, *Furcifer oustaleti*, measures 27 inches in length (Preston•Mafham 1991). Their conical eyes, moving independently, can look forward and backward at the same time, swiveling almost 180 degrees in either direction (Preston-Mafham 1991). This adaptation, processing totally divergent information spontaneously, would confuse most vertebrates, but chameleons, even very young ones, are adept at using these dual periscopes to locate insects and other prey. They hold onto the thinnest branch with their prehensile tails, and with long, thin legs bent at the knees, they walk in an odd back-and-forth swaying motion that resembles leaves moving in the wind. Their chunky bodies and spindly legs give them an awkward appearance, but they are superbly adapted to catching their prey by unfurling a long, sticky tongue--curled upside their mouth--with lightning speed, nailing an unaware insect with astonishing accuracy.

Their camouflage coloration, which varies greatly from bright greens, mottled browns, reds and blues, helps protect them from avian and mammal predators. Contrary to general opinion, chameleons do not change colors as they move about in the trees or on the ground to match their background. When they suddenly change colors, it is as a territorial or sexual display meant for other chameleons (Preston-Mafham 1991). Some species have horns and other protuberances, giving them the appearance of miniature dinosaurs. A few species show sexual dimorphism, or a physical difference between the sexes. The contrast can be so striking that some were considered separate species when first identified (Burger and Price 1996). In one species, for example, the female is black and yellow, and the male a mottled brown and white (Burger and Price 1996).

Chameleons are heavily exploited by collectors who capture them for sale in pet stores around the world, threatening them. Collectors will pay $1,000 or more per animal for rare species. This trade, which involves thousands of individuals, has caused declines in many species. The Malagasy government has banned trade in most species, but enforcement is not strong. One chameleon, *Chamaeleo brevicornis*, of which 795 were exported in the first six months of 1990, is restricted to only a few areas of primary forest (Behra 1993). An ongoing study will evaluate whether to allow trade in the commoner species. Chameleons captured and shipped abroad for the pet trade suffer very high mortality as a result of inhumane transport conditions and inadequate care in pet stores and people's homes. They require special conditions of temperature and humidity, and many have specialized diets. In short, they are not suited to being house pets. In the care of specialists, they can be kept alive, but most captive breeding has been unsuccessful. Some of the rarer species, such as the beautiful blue-green Parson's Chameleon (*Chamaeleo parsonii*), which can reach lengths of more than 20 inches, have not been bred to the second generation**,** and mortality is high. All chameleons are on Appendix II of CITES, which requires export permits, but none has been listed on Appendix I of CITES, which would ban commercial trade.

Although some chameleons have adapted to disturbed habitats, such as weedy fields and shrub landscape, the majority favor natural habitats. The small *Brookesia* chameleons, of which one species is listed by IUCN as Vulnerable (Hilton-Taylor 2000), require undisturbed, primary old-growth forest. Three other chameleons, all *Furcifer* genus, are listed as Vulnerable by IUCN. All are in decline, approaching endangered status.

Although many Malagasy regard chameleons as ugly porters of bad luck (Burger and Price 1996), for tourists, they are the second most popular animals, after lemurs. Some Malagasy, aware of the fascination with which chameleons are held by tourists, capture them and offer them for viewing or sale.

Another lizard being captured for the pet trade is the extraordinary 4-inch-long Leaf•tailed Gecko, *Uroplatus fimbriatus*, a true master of camouflage. Resting during the day with its head tight against a tree trunk, an elaborate lacy fringe along the underside of the body allows it to melt into the tree, while its skin is patterned to resemble tree bark. Even its golden eyes are streaked with tiny dark lines that imitate bark. With broad, flattened front feet splayed out against the bark and hind legs held vertically under a spatula•like tail, it becomes virtually invisible (Preston•Mafham 1991). If discovered, however, it has a defense. Opening its mouth wide to reveal a crimson•red tongue, it raises its tail vertically and emits an ear-splitting screech, no doubt intended to be a fearsome display (Preston•Mafham 1991, Tyson 1994). Malagasy boys have discovered the haunts of the Leaf-tailed Geckos, and

capture hundreds--thousands by their accounting--for sale to foreign middlemen who pay them less than $1. They are sold in the United States for $250 a pair (Tyson 1994, Tyson 2000). On Nosy Be island off the northern coast, schoolboys claim to have captured 40,000 over the past six years (Tyson 2000). A threatened gecko, Standing's Day Gecko (*Phelsuma standingi*), is native to the spiny forests of the south and is one of the most coveted by collectors (Tyson 2000). It is hunted out of many areas because Malagasy have captured hundreds, receiving $1.20 per gecko, while reporting only a few to authorities (Tyson 2000). It is on CITES Appendix II, and sells in the United States for $80 to $200 apiece (Tyson 2000). Most species of geckos bring the village collectors only about 3 U.S. cents, while the exporter receives $9 to $13 and U.S. retailers get $75 or more (Burger and Price 1996). In most cases, these pet reptiles live a very short time, and represent a mere toy to the consumer.

The export trade in live lizards involves an enormous number of animals. One gecko, *Phelsuma serraticauda*, was known only from a few museum specimens until 1,360 specimens were chronicled as exported during the first six months of 1990 for the pet trade (Behra 1993). During this same period, 22,837 lizards--geckos, *Phelsuma* genus, and chameleons, *Chamaeleo* genus--were exported from Madagascar (Behra 1993). Between 1986 and 1991, almost 145,000 lizards of 17 species were exported; of these at least 38,325 were chameleons of 21 species (Burger and Price 1996). Many of these are species that are endemic to restricted areas, or threatened in the wild. The U.S. Fish and Wildlife Service™s fiOperation Chameleonfl succeeded in arresting 19 people in 1998, among whom was a major Malaysian smuggler and an American, Tommy Crutchfield, who was arrested at Miami International Airport with suitcases full of rare snakes, tortoises and lizards. In another case, a Canadian and a Dutchman were arrested at Chiang Kai-shek International Airport in Taiwan with numerous chameleons and geckos, including some threatened Standing's Day Geckos.

Several gecko species have extremely limited ranges. A newly described leaf gecko, *Uroplatus malama*, is known from a single specimen taken in a remnant of lowland rainforest in southeastern Madagascar (Burger and Price 1996). Only two specimens of a closely related species, *Uroplatus malahelo*, exist, native to a small patch of forest in the south (Burger and Price 1996). When discovered, its habitat was being logged, and the species may already be extinct (Burger and Price 1996). An extremely rare lizard, *Zonosaurus boettgeri*, known from two specimens that were taken in the 1890s and subsequently disappeared, has been rediscovered on the island of Nosy Be by herpetologist Chris Raxworthy and volunteers from Earthwatch Institute (Tyson 2000). The two individual lizards were killed as specimens upon rediscovery (Tyson 2000).

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Among Madagascar's 80 types of snakes--all non-poisonous--are three boas, whose closest relatives are found in South America (Burger and Price 1996). They are thought to be among the island's most ancient inhabitants, resident since the early breakup of Gondwana (Preston•Mafham 1991). All are considered Vulnerable by the IUCN (Hilton-Taylor 2000): Dumeril's Boa (*Acrantophis dumerili*), Madagascar Boa (*Acrantophis madagascariensis)*, and the Madagascar Tree Boa (*Sanzinia madagascariensis*). The first two are Madagascar's largest snakes, reaching almost 6 feet in length; Dumeril's Boa is restricted to the south and southwest, while the Madagascar Boa is found in the north and northeast (Preston•Mafham 1991). Both species require humid habitats along streams and watercourses. Placid and slow•moving, they are often killed or captured by local people. The Madagascar Tree Boa is smaller and more common, shaded in delicate grayish-green with a purplish•blue tinge. Little is known of any of these species' life histories and diets (Preston•Mafham 1994). A very rare and possibly extinct snake, *Pararhadinea albignaci*, is known only from a single specimen picked up, dead, off the road in eastern Madagascar in 1970. This species has never been seen alive in its forest home (Preston-Mafham 1991).

One of the most extraordinary snakes in the world, *Langaha nasuta*, mimics a dry, pencil-thin twig to camouflage itself among the leaves. The female's nose is extended into a leaf•shaped structure adorned with scales and small

tooth•like projections, while the nose of the male is elongated, tapering into a sharp point to resemble a thorn (photo in Preston•Mafham 1991 and Lamar 1997).

A smuggling operation involving hundreds of Madagascar reptiles was exposed in August 1996, when six men were charged with conspiracy to smuggle rare Madagascar reptiles into the United States and Canada. According to the U.S. Justice Department, two men were arrested at Orlando International Airport in Florida with 61 Madagascan tree snakes in their suitcases that were to be sold at a large reptile breeders show in Orlando (Reuters 1996). Four Germans, one Canadian and one South African were indicted. Simon Harris, the South African, had $100,000 worth of rare reptiles in his luggage; he cooperated to implicate the other suspects, who are still being sought (Reuters 1996). These smugglers shipped snakes and tortoises, concealed in suitcases, from Europe to Canada and the United States and received payment by international wire transfers. Most of the snakes and tortoises were listed on CITES. In 1998, 26 Madagascan Tree Boas were seized in Belgium, and an American reptile dealer was caught by the U.S. Fish and Wildlife Service with the latter species and Dumeril's Ground Boas in his luggage at Miami International Airport (TRAFFIC 1999a).

The sea turtles inhabiting Madagascar's coastal waters are heavily exploited in spite of their listing on Appendix I of CITES. A survey in 1971 estimated that 13,000 were killed along the west coast alone (Burger and Price 1996). Little is known of their present populations.

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Some 176 species of amphibians, all frogs, have been named and described (Mittermeier *et al.* 1999). Raxworthy estimates that there are another 124, many of which have already been found but not yet described scientifically (Tyson 2000). Salamanders and toads are absent from Madagascar. All but two frogs are endemic, one of which was introduced from Asia by French colonialists as a gourmet food source (Burger and Price 1996). The majority are native to rainforest environments, the most endangered type of habitat on the island. In one such area, a montane rainforest in the Andasibe region, 90 species are native--the highest diversity of frogs in the world (Burger and Price 1996). Since 1990, 13 new species of a single, colorful genus, *Boophis*, have been described, and others await naming by scientists (Burger and Price 1996). A candidate for the world's smallest frog--and perhaps the world's smallest vertebrate--is a minute frog, *Stumpffia pygmaea*, which measures less than 3 millimeters in length (0.117 inches) (Burger and Price 1996). This frog lays its eggs in foam nests hidden among leaves on the forest floor, and the tadpoles grow into froglets without ever feeding (Burger and Price 1996).

The most spectacular Malagasy frog may be the bright red Tomato Frog (*Dyscophus antongili*), which secretes poisonous white mucous when threatened. Some authorities consider the species to be endangered (Bauer 1995), while the *2000 IUCN Red List of Threatened Species* lists it as Vulnerable. To protect it from trade, it is listed on Appendix I of CITES. Fat and squat, this toad-like frog is large enough to cover the palm of a hand (Preston-Mafham 1991). Tomato Frogs have a very restricted range in the region of Tamatave on the east coast; some live in plantations, where pools of water gather, and even in garden ponds (Preston-Mafham 1991). Collectors, pet dealers and zoos have offered thousands of dollars for these frogs, and illegal shipments containing 40 or more Tomato Frogs have been confiscated.

One study entitled "The Export of Reptiles and Amphibians from Madagascar," by Olivier Behra (1993), chronicled the extent of exploitation of frogs. In 1988, 230 frogs of the genus *Mantella*, endemic to Madagascar, were exported. The demand increased, causing exports to rise astronomically to 11,058 in 1989; in the first six months of 1990 alone, almost 11,000 were exported, mainly to Denmark and other European countries, the United States and Japan (Behra 1993). These brightly colored little frogs are sold as pets and to decorate terrariums. The most popular Madagascar frog in this trade is the tiny Golden Mantella (*Mantella aurantiaca*), of which 3,237 were exported in the first six

months of 1990 (Behra 1993). This frog is restricted to eastern Madagascar, and is apparently rare and declining (IUCN 1994). It lives in pandanus swamps in rainforests, which are rapidly disappearing, and no part of its habitat has been set aside in a reserve (IUCN 1994). Unlike most frogs, the Golden Mantella is slow-reproducing (IUCN 1994). In the 1990s, 3,000 to 6,000 were exported annually from Madagascar, and in 1994, two proposals sought to list this species on CITES, one on Appendix I and the other on Appendix II. The latter proposal succeeded, which is unfortunate, since it allows the trade to continue. The *2000 IUCN Red List of Threatened Species* lists the Golden Mantella as Vulnerable (see photos of gold and red phases of this species in Lamar 1997).

In 1998, two people were arrested in Taiwan trying to smuggle frogs of two *Mantella* species (*Mantella madagascariensis* and *Mantella aurantiaca*), along with some Madagascar lizards. Another seizure of 50 Mantella frogs occurred at Zaventem Airport in Belgium in 1998 as they were being smuggled from Madagascar (TRAFFIC 1999a). Such seizures involved shipments without the proper export permits. Appendix I listing under CITES would provide greater protection.

The Biological Wealth of an Impoverished Country: Invertebrates

Like the rest of its fauna, Madagascar's invertebrates are extraordinary. One insect from the age of the dinosaurs, the Giraffe-necked Weevil (*Trachelophorus giraffa*), has an elongated neck which rises vertically, then makes a right-angle turn and extends horizontally, and ends in a tiny head with furry antennae. Amazingly, this insect has counterparts in New Zealand known as giraffe weevils (Molloy 1994). This may be explained by the fact that New Zealand was also part of Gondwana prior to its breakup (Molloy 1994). Other ancient species include the 100 species of hissing cockroaches. Some are far larger than any other cockroach species in the world; their heavy bodies resemble long-extinct trilobites. The largest species measure up to four inches long, and thousands are exported for the novelty pet trade and for zoos. When touched, they hiss loudly, and males aggressively charge one another with their armored, knobbed shields (Preston-Mafham 1991).

One of the richest land-snail faunas in the world is native, with more than 380 species named so far, 361 of which are endemic and differ greatly from land snails in Africa (Preston-Mafham 1991). Many are threatened, however, by introduced African Giant Snails (*Achatina fulica*) and several other non-native snails introduced to control the African Giant Snail, but threatening native species instead. One native snail, *Tropidophora deburghiae*, is considered endangered by some authorities. Brilliantly colored slugs, or shell-less snails up to 6 inches long, striped in black-and-red or yellow-and-brown, live on the damp rainforest floor (Preston-Mafham 1991). Many have limited distributions and can be easily eliminated by habitat destruction (Preston-Mafham 1991).

An extremely ancient family of spiders, Archaeidae, first described from a specimen frozen in amber several million years old, has seven species on Madagascar, one in South Africa, three in Australia, five in New Zealand and one at the tip of South America; these species appear to be vestiges from the ancient supercontinent (Preston-Mafham 1991). The Archaeidae spiders have strange, grotesquely shaped bodies, visible only through a microscope since they are only 0.14 inches long; they live among leaf litter on the ground (Preston-Mafham 1991). Some Madagascar spiders are extremely bizarre, with shapes that resemble bat-winged leaves, bright red thorns, or mottled brown lumps on logs (Preston-Mafham 1991).

Millipedes on Madagascar reach 6 inches and exude droplets of poison when attacked; Brown Lemurs have found ways of avoiding this toxin and feed on them (Preston-Mafham 1991). Shield-bugs, or stink-bugs, of the family Pentatomidae, have 220 species on Madagascar, many of which are brightly colored in reds, oranges and blacks; 120 species of water bugs, of which 80 percent are endemic, and a variety of assassin bugs add to the rich insect fauna (Preston-Mafham 1991). About 20,000 beetle species, including 500 species of endemic jewel-beetles, are native to Madagascar. Jewel-beetles, with their colorful, metallic bodies, appear during the rainy season in southern and

western forests (Preston-Mafham 1991). Many species of scarab beetles, among which are dung beetles, are also native to Madagascar; one endemic genus, *Helictopleurus*, roll the dung balls into their nests and lay their eggs in them (Preston-Mafham 1991).

Madagascar's butterflies, totaling 300 species, are not as diverse as in some parts of the world, such as the Tambopata Natural Reserve in Peru, which has 1,300 species. This may be because they colonized the island fairly recently. Another possibility is that many species have faded into extinction, leaving no trace, when the plant species upon which they depended were driven to extinction by habitat destruction. Since 80 percent of the island's forests have been cut, hundreds or thousands of species may have disappeared without a trace millennia ago. One Madagascar butterfly, a pale cream-and-black Swallowtail, *Papilio mangoura*, is hotly pursued by collectors because of its rarity (Preston-Mafham 1991). Several butterflies of the Nymphalidae family, or Fritillaries, are threatened, as are two species of the family Acraeidae.

In the 19th century, Charles Darwin learned of a spectacular, white Madagascar orchid (*Angraecum sesquipedale*) that had an extremely long, nectar-bearing tube dangling down from the flower. He reasoned that it could be pollinated only by an insect that could reach its nectar. He guessed that it might be "some huge moth, with a wonderfully long proboscis." Entomologists verified his belief with the 1903 discovery of the hawkmoth, *Xanthopan morgani praedicta*. This moth has a 9-inch tongue that it keeps wound in a spiral in its mouth, unfurling it to reach the nectar of this particular orchid. In a similar arrangement, another orchid (*Angraecum arachnites*), exudes a strange odor that attracts only one pollinator, the rainforest hawkmoth, *Panogena lingens* (Preston-Mafham 1991). The nectar at the base of this orchid's long, twisted tube can be reached only by this single species of moth--and not even every individual, but only one race of this moth which has a long, tapered proboscis (Preston-Mafham 1991). These species co-evolved, and should the moths become extinct, the orchids would have no pollinators and would follow them into extinction. Another unusual moth, the huge Comet Moth (*Argema mittrei*), is one of the largest moths in the world (Preston-Mafham 1991).

Preserving Madagascar's Natural Wonders

This fourth largest island in the world is, in many respects, a minicontinent. This evolutionary treasure-house is of great importance from a worldwide perspective. Madagascar's diversity of life forms is so great that as many as 200,000 species, most of them undescribed, may be native, of which an estimated 150,000 are endemic species (Daley 1997). The habitat loss is proceeding so rapidly, however, that the underfunded biological assessment studies will be unable to appraise this biological wealth before it disappears before their very eyes. Logging and burning have reduced the forested area from 120,000 to 20,000 square miles; this destruction still consumes vast areas each year (Daley 1997). It is estimated that all the remaining accessible forests will disappear within the next 35 years (Sayer *et al.* 1992). With the impending loss of these treasures, many conservationists and scientists consider Madagascar the world's most threatened natural area (Sayer *et al.* 1992).

Less than 5 percent of Madagascar is protected in reserves and parks. Even if these lands remain intact, they represent too small a percentage of forest to preserve the island's genetic heritage. Other than Masoala National Park, which encompasses most of an entire peninsula, some 840 square miles, most reserves are relatively small--islands of forest surrounded by denuded land. Should all surrounding forest be leveled, these isolated fragments would not be sufficient to prevent genetic impoverishment, inbreeding, and eventual extinction of the very species the reserves were meant to protect. Recent research in the Amazon has shown that forest fragmentation results in extinctions, in direct relation to the size of the reserve (Peters and Lovejoy 1990). The larger the reserve, the fewer extinctions. For this reason, Masoala National Park is receiving special attention from scientists. Stanford University's Center for Conservation Biology is analyzing a Geographic Information System (Kremen 1998). So far, this research has revealed that forests on the eastern border of the park are the most threatened, with a likelihood that they will be

completely burned away within 25 years (Kremen 1998). The borders of the park were delineated according to the results of biological surveys, a method that is so new that it has not even been used in the United States. Claire Kremen of the Wildlife Conservation Society, with additional support from the National Geographic Society, worked with a Malagasy entomologist and two American ornithologists to conduct detailed biological species diversity studies in this rugged terrain (Kremen 1998). Five new species of butterflies and many other insects were discovered. Each had its own micro-habitat, endemic to that area. Habitats included in the national park are lowland rainforest; cloud forest and montane heath; coastal and seasonally flooded forest; mangrove; marsh; estuary; bay; lagoon; and coral reef. Lemurs and a vast array of wildlife and plants will benefit from this new park.

Masoala National Park will not displace villages but will conduct education programs and involve them in the conservation of local wildlife. The Missouri Botanical Garden is also involved in the management of Masoala National Park, helping to inventory its rare plants and working with local people for non-destructive agricultural and fisheries industries. Work is also proceeding to stop the cutting of forests for firewood on Masoala and to provide public education on land use (Sayer *et al.* 1992). Some 300 or so villages exist within or nearby Masoala National Park, and the cooperation of the local people is crucial to the success of this park. The final plan for the park involved a compromise in which some cutting of four relatively fast-growing trees, including rosewood, would be allowed. Local communities, which will profit from the products, will be allowed to harvest palm seeds and butterflies. This will prevent the slash-and-burn destruction that was eating rapidly away at this forest (Kremen 1998). This park's endemic plants and animals, including the Red Ruffed Lemur, which exists only in the park, rely for their survival on the protection of this last sizeable rainforest. It will represent an experiment in conservation management that will have serious consequences should it fail. It is, however, one of the first times that ecological rules are being worked out with large numbers of local people to help protect such a large area. Elsewhere in Madagascar, similar projects are in the works.

Many of Madagascar's rarest species are not protected in any reserves, however, and may soon be lost. Reserves and parks, the last refuge for many species, are regularly pillaged for trees, and wildlife is killed or captured. A herpetologist surveying in Bemaraha Reserve, in the western part of the island, discovered a pile of illegally cut trees that had been marked with red paint as part of a botanist's study by the trail in 1996 (Holmes 1997). This is not an isolated occurrence. The native wildlife and plants are among the most endangered in the world. More than 124 vertebrate species are listed in the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000), as well as 306 species of plants (Walter and Gillett 1998). While this crisis is occurring, new species of lemurs, reptiles, invertebrates and plants are being discovered, making the preservation of the environment all the more urgent. Obviously, the amazing biological diversity of Madagascar has not been fully assessed and may be far greater than previously thought.

Several species thought long-extinct are rumored to survive, adding even more mystery to the picture. Many Malagasy have told scientists of having seen an animal that might be a pygmy hippopotamus. Shown a picture of an African Common Hippopotamus, they have said that it was similar, but had floppy ears, uncloven hooves, dark skin, except for pinkish areas around the eyes and mouth, and was the size of a calf or small cow (Tyson 2000). As recently as 1976, a man told biologists of having seen and heard one grunting; many unsolicited, independent accounts from Malagasy have agreed on these details (Tyson 2000). They call the animal "kilopilopitsofy," and many are afraid of being chased by it (Tyson 2000). The Common Hippopotamus of Africa also grunts and kills more people than any other animal on the continent.

A long-lost primate, ground-dwelling and the size of a 7-year-old child, has also been reported by several Malagasy (Tyson 2000). This may be the same animal that was described to primatologist Alison Jolly (1980). A Malagasy told her that he had been given a young lemur of a type he had never seen before. This lemur had very dark fur, walked on its hind legs, one foot after the other, rather than hopping like a sifaka, and had a flat face different from the pointed muzzles of living lemurs. After only two months, this lemur died, and its skeleton was buried in an unknown place (Jolly 1980). An old man recently told a similar story of having seen such an animal in 1952. Called the "kidoky" by others who have seen it, it has a dark coat with white spots above and below a flat, round face. When alarmed, it flees

by leaping forward in short hops like a baboon. Its call was described as a long, single whoop, and other villagers who had seen the animal said it was solitary (Tyson 2000). Scientists have said that if it exists, it might be an *Archaeolemur* or *Hadropithecus* (Tyson 2000). The fact that their descriptions seem so similar to species known to have existed makes them all the more intriguing.

Alarm calls about the impending demise of Madagascar's natural world have been sounded for decades (Jolly 1980, 1988; McNulty 1975; Preston•Mafham 1991; Tyson 2000). Visitors to the island are united in their descriptions of a ravaged, eroded and deforested land. Jacques•Yves Cousteau and his team visited the island for a television special aired in 1995. As they sailed toward Madagascar, they were stunned to see huge, wide, red stains of eroded soil in the water, emanating from the island's rivers, and wisps of smoke from burning forests. These red rivers are bleeding the island's life blood, its topsoil. They are so pronounced that they are among the few natural phenomena on Earth visible from orbiting space craft. Cousteau's helicopter flights over the central plateau revealed a landscape among the most devastated on the planet. A research team sponsored by Earthwatch Institute described the island from the air, "Two features of the landscape stood out even from 10 kilometers up: barrenness and smoke" (Tyson 1994).

Although erosion remains a major problem, some progress has been made to stop it (Morell 1999). Erosion costs Madagascar between $100 million and $290 million per year, caused mainly by the continued slash-and-burn agriculture (Tyson 2000). It has been extremely difficult to convince many Malagasy that the last of the forests will disappear within a generation if they do not seek alternative means of growing crops. To that end, Cornell University's International Institute for Food, Agriculture and Development, run by Norman Uphoff, has been helping farmers in the vicinity of Ranomafana National Park (Tyson 2000). These desperately poor farmers have no electricity or plumbing and struggle to feed large families on soil that is leaching its nutrients. Norman Uphoff discovered that the native Wild Ginger plant had high concentrations of phosphate, and he encouraged its use as fertilizer (Tyson 2000). By supplying seedlings and information, the Cornell program also has helped establish fish farms. Their agronomists have advised farmers to mix crops and to plant certain species in order to keep the soil rich and retard erosion; they have supplied seedlings (Tyson 2000). This agricultural advice has been helpful, but because some rural people have so many children, many are unable to produce enough crops to feed their families (Tyson 2000). Other projects involve encouraging rice cultivation with more suitable seed varieties, improved irrigation systems and application of fertilizer (Garbutt 1999). Using native bees in honey-making is also being taught to the Malagasy, who often fell old-growth trees to obtain honey (Garbutt 1999). The Kew Botanical Gardens in London and Britain's Royal Palm Society are researching the marketing of seeds from some native palm trees (Terry 1996).

International aid organizations could help preserve forests by donating fertilizer so the Malagasy would not need to practice slash-and-burn when forest soil ceases to produce crops. The urgent task of supplying the Malagasy people with methods of producing food and fuel in environmentally non-destructive ways has just begun. Villagers would be more likely to preserve trees now cut for firewood if they were provided with solar cookers or given propane tanks for fuel. Bio-gas, or methane, produced by animal dung and sewage, could be used to provide fuel and fertilizer. Such projects have been launched by international agencies in some countries of Central Asia.

Madagascar's human population is growing at a rate of 3.1 percent per year and reached 12,596,000 in 1992 (55 persons per square mile) (Anon. 1994). By 1995, it had grown to 13.9 million (61 persons per square mile) (McNeil 1996b). Another increase to 14,462,509 people (64 persons per square mile) was registered in the 1999 *World Almanac*. The *2001 New York Times Almanac* noted a population of 15,506,472, based on a July 2000 estimate. Thus, 3 million people were added to the population in just eight years. Along with the original Asians, more recent immigrants from Africa, India, Pakistan, China, Europe, and Arab countries add to the diversity. They have long since passed the carrying capacity of the land, and rice must be imported to feed the people. As one of the world's 12 poorest countries, Madagascar's external debt is approximately $4.25 billion. Average annual income is only $780 (NYT 2000). The unemployment rate is about 33 percent, and 51 percent of children are malnourished, according to a study by USAID (Tyson 2000). The literacy rate is 46 percent, and only 42 percent of children attend schools; 70 percent of children ages 6 to 9 have had no formal education (Tyson 2000). Jacques Cousteau's team filmed hordes of desperately poor people as they combed dumps for scraps of metal and food. Some people even live in these dumps in

holes they have dug in the soil. Such scenes are symptoms of extreme overpopulation and rampant poverty that can also be seen in parts of Brazil and Asia.

One of the reasons that illiteracy is so high in Madagascar is that millions of people must spend their days searching for food, water and firewood, requiring the help of their children, who are then unable to attend school. In general, foreign corporations have looted the island's resources, leaving no economic base that would help the people as a whole. One U.S. company, the Esso Corporation, is owed $25 million by the Madagascan government and demanded payment in spite of the country's cash reserves of less than $2 million (McNeil 1996b). Because of the country's debt levels, the World Bank and the International Monetary Fund are now in charge of its finances (McNeil 1996b), a potentially dangerous situation for both the people and the environment. On the positive side, a "Debt for Nature" swap was carried out in Madagascar, in which a portion of the foreign debt was exchanged for the establishment of nature reserves and parks.

To date, efforts to slow the population growth rate are still in their early stages. A program that addresses population growth, based not on threats or punishment, but on persuasion, was launched by Population Communications International (PCI) of New York City in 1996. As the organization has done in other countries, it trains local people to create communication programs for radio and television with a message that limiting family size is advantageous. The majority of the population on the island lives in cities and has access to these media. The programs, described as "soap operas" by PCI, create melodramas with characters the audience can identify with, who act out dramas. The characters in these dramas come to realize that different behavior, such as having fewer children, will result in positive changes in their lives (Ryerson 1994). In many cases, this involves elevating the status of women, and convincing men that women must be allowed to make decisions about their own reproduction (Ryerson 1994). PCI is cooperating with organizations that are actively trying to conserve the wildlife of Madagascar, such as Conservation International and the African Wildlife Foundation. Ranomafana National Park began a family planning center in 1994 to help the people of the region, many of whom have as many as 14 children, of which 62 percent are underweight and 17 percent malnourished, according to a study by the University of North Carolina (Tyson 2000).

Madagascar is a magnet for scientists from around the world and has been the recipient of millions of dollars in foreign aid and grants from international conservation agencies. Conservationists are initiating many highly inventive and effective programs to interest the Malagasy in conservation and employ them in biodiversity work. Environmental education is a key to the future of Madagascar, and programs are being carried out at Beza-Mahafaly Reserve. This protected portion of endangered spiny desert and shrubland was established when the local Mahafaly people agreed to donate the land, and funds were raised by Alison Richard, a Yale primatologist, for a training program for Malagasy scientists (Tyson 2000). Patricia Wright has set up a similar program in which Malagasy students complete master's theses based on wildlife research in Ranomafana National Park, and some students travel to the United States to receive advanced training in biodiversity and environmental protection (Tyson 2000). They will help guide the country in new directions in the future. It also opens new worlds to these students, who, in turn, will make young people aware of the natural treasures in their country. Schools that Patricia Wright has helped establish in the area of the park teach environmental education to young people. Others are also helping introduce this subject to children. Josephine Andrews, a Scottish scientist studying Black Lemurs in Nosy Be since 1988, teaches children about the lemurs with the help of a Malagasy named Julien, who guides people around the forest preserve (Tyson 2000). "If the kids are really into it, then the adults will switch on as well," she said (Tyson 1994). Forests are the key to the future survival of the island and its people, and an education program aimed at rural people, teaching the value of trees in preventing floods, landslides and in maintaining the flow of rivers and streams, could save countless trees.

Scientists--both Malagasy and foreign--working on the island, could share their findings by talking with local people about the uniqueness of Madagascar's natural world. Ornithologists with the Peregrine Fund, who rediscovered the Red Owl and taught local schoolchildren about the species donated money from bird-watchers to the school, provided such an example. Scientists typically conduct research and depart without having taught local people about their findings. Villagers near Ranomafana National Park were so interested in learning about research results that they asked Wright for copies of reports. She began a bimonthly newsletter, in the Malagasy language, describing the

natural history of the park (Tyson 2000).

Films and books about Madagascar's wildlife and plants tend to be distributed only in foreign countries, and never translated into Malagasy. Translations of books and subtitled films could be shown to schoolchildren to introduce them to Madagascar's tremendously interesting and beautiful natural world. It is ironic that Westerners may be more familiar with lemurs and chameleons that most Malagasy. Some projects for the future might include donation of solar collectors and windmills to supply power to rural people. This could elevate their standard of living and cut back on firewood collection for fuel. Donation of projection and video equipment to regional schools provided with electricity would help them appreciate their natural heritage through viewing nature films of Madagascan wildlife. Satellite dishes would facilitate communication with people around the world through the Internet.

The government of Madagascar developed a 20-year National Conservation Strategy and Environmental Action Plan as long ago as 1984. In 1986, a survey of protected areas began with the aim of implementing management plans for priority protected areas and recommending new protected areas, as well as training Malagasy people to work in reserve management and conservation biology. The government has been working to create a sense of pride and ownership in the nation's biodiversity through this program (Morell 1999). The President of Madagascar has stated that the environment is important, a key to whether foreign scientists and tourists will be able to come to the country and aid in its conservation in the future (Tyson 2000). The World Bank and various organizations funded this Environmental Action Plan with $168 million for its first five years (Tyson 2000). This has resulted in many biological studies, education of a growing number of Malagasy for conservation work and a Biodiversity Planning Centre (Sayer *et al.* 1992). The Geographical Information System database is a cornerstone of the government program, concentrating data from all fields to help establish conservation priorities (Tyson 2000). Conservation International has an office in the capital and is contributing to biological inventory data, as it has in other countries, as well as conducting research on particular species and data management. It coordinates its work with local organizations and trains Malagasy scientists (Sayer *et al.* 1992).

Ecotourism is another budding industry, and Madagascar is one of the few countries in the world to share park fees with local people. As a result of an initiative put forth by a Malagasy non-governmental organization, the National Association for the Management of Protected Areas, one-half of all fees are given to local people (Tyson 2000). Ninety-three villages in the Ranomafana National Park area received about $10,000 in a recent year from park fees; a committee designated by the villages decides how to spend the money. In 1995 they bought seeds and built campgrounds, a crafts training center and small dams (Tyson 2000). Many local people are employed as park workers, and the aim of the program is to turn over management of this park and its biodiversity work to the Malagasy people. There needs to be a national park system with strict rules for management and protection, according to Patricia Wright, who deplored the illegal tree cutting by the previous park director at Ranomafana (Tyson 2000). She also has proposed that a national biodiversity institute be built, which would offer centralized training in biology and technology, as well as five new long-term biodiversity research stations similar to those in La Selva National Park in Costa Rica and the Smithsonian Institution's Panama tropical research laboratory (Tyson 2000).

Jobs, which are desperately needed by the Malagasy, are increasing as a result of the rise in the number of tourists. Selling crafts to tourists, running hotels and restaurants, and serving as guides are among these. Villagers who used to demand that parks be declassified so that they could legally gather wood, now request that more national parks be established, an apparent result of the new income that comes from fees and tourism (Morell 1999). International tourists have provided a major new source of revenue in Madagascar's economy and are helping the Malagasy see their wildlife in a new way, as so fascinating and biologically important that visitors come from every continent to view it. *Madagascar. The Bradt Travel Guide*, by Hilary Bradt (1999), published in various editions since 1988, is a useful aid for tourists, providing information about accommodations, natural history, protected areas, and the Malagasy and their history. Nature reserves and parks provide jobs by attracting scientists who employ local people, another incentive for the Malagasy to urge that more protected areas be set aside.

Compensation for lost access to forests has not been paid in the past, and new arrangements reached with villagers to

allow some extraction of resources from the forests may heal some of these wounds and placate those who still wish to cut trees. Medicinal plants obtained from Madagascar may be another source of revenue in the future. The Rosy Periwinkle may be only one of many native plants highly valuable in treating disease. Research on the potential of other plants may uncover other such treasures. In the past, revenues from plants used for medicine have not been returned in part to the country of origin, but recently a new trend has begun. In one case, a pharmaceutical company agreed to pay people in a South American country a portion of the revenues gained from any native plant providing a marketable drug.

Another potential source of revenue is the placement of videocameras connected to the Internet, which present websites with general information as well as live camera views of wildlife. South African parks have a number of these videocameras placed at water holes, animal dens and other key areas that capture live views of animals transmitted to the Internet for a small viewing fee. This has proven very successful, funding many of the South African National Parks system™s expenses. A similar system could be established in Madagascar with solar-powered videocameras, which have already been in use in Alaska, trained on tree canopies, rainforest flowers or lemurs, along with websites that provide basic information on Madagascar's environment, biodiversity and the Malagasy people. For millions of people who cannot visit Madagascar, such a website might be fascinating as a learning tool for teachers and the public, as well as an exciting view of these unique animals and their environments. If managed in such a way that profits were shared between poor Malagasy to alleviate their poverty, and conservation organizations to preserve biodiversity, such a system has great potential.

A satellite connection with classrooms in the United States or other countries would be another opportunity for interactive communication and learning. In December 2000, for example, students in an American classroom talked with students in a school in Guyana about endangered Giant Otters and their conservation through a visual satellite hookup. Students and others might set up an interactive link with biologists and conservationists working in Madagascar, asking questions and offering help. Students have provided many excellent ideas for conservation, and classes have raised money to save rainforests and threatened wildlife habitat and to help stop poaching of endangered species in countries half a world away from their own. Malagasy young people might be inspired and enthusiastic through talking with others of their own age about conservation and biodiversity. Video cameras and still cameras might be donated to Malagasy students and young people to record nature and compete for prizes with their results.

Madagascar™s Lessons

Madagascar's story is one of ecological catastrophe and the gradual extermination of its life forms. One's first response might be that its experience is as far from the rest of the world as it is geographically remote. However, it is from the extremes that one acquires basic knowledge. The effects of immigrants, whether human, animal, plant or disease, can devastate natural ecosystems wherever they occur. Islands are especially vulnerable to the effects of invasive species, including humans, because their flora and fauna have limited habitats and tend to be endemic, with small populations.

Exotic or non-indigenous species threaten 350 species of birds, or 30 percent of all threatened birds listed by BirdLife International in *Threatened Birds of the World* (BI 2000). Likewise, 361 plant species and 69 species of mammals listed by the *2000 IUCN Red List of Threatened Species* are threatened as a result of non-indigenous species (Hilton-Taylor 2000). The effects of invasive species, including humans, have been the major cause of extinction of virtually all bird species, almost all of which have occurred on islands. In the case of Madagascar, the Malagasy and other immigrant peoples and their livestock, and their subsequent hunting and habitat destruction, presented the vulnerable native species with threats against which they had no defense. Islands throughout the world continue to suffer losses in biodiversity, as do areas with large numbers of endemic species in mainland areas. Species with restricted ranges are the most likely to go extinct or become endangered. Such species dominate the list of birds in

Threatened Birds of the World (BI 2000). In this age of international commerce, where plant diseases and other viruses are brought into countries in shiploads of lumber or ballast water, and exotic animals and plants continue to colonize and be released in delicate ecosystems with endemic species, whether on islands or mainlands, it has become extremely difficult to defend native species from such invasions. Nevertheless, through preserving native plants and animals and legislating against such introductions, while removing non-native species, ecosystems and their diversity can be protected. Preserving natural ecosystems is vitally important, not just for wildlife preservation, but for humans as well, so that precious water supplies, topsoils and biological diversity, which stabilize all ecosystems, are protected. These lessons have not yet been put into practice in Madagascar or in many other parts of the world, including developed countries. Ecological and faunal changes may be so gradual that they go unnoticed until ecosystems have been destroyed.

Madagascar Testing Quotes

About 500 A.D., immigrant people from Asia, most probably Indonesia or Malaysia, arrived on Madagascar's shores in hand-hewn canoes, bringing domestic animals with them. They began clearing forests and burning them for farmland, and turned lakes and wetlands into rice paddies. Cleared land produced crops for only a few years until the thin soil became sterile. Farmers then moved on to other parts of the forest, in this slash-and-burn agriculture. At some point, African herdsmen colonized the island, bringing zebu cattle, which crowded out wildlife (Tyson 2000). Gradually, abuse of the land eroded the soil in the central highlands to bare earth, pocketed and gouged by deep gullies and cavernous holes. This region had harbored a great variety of lemurs, along with a wealth of birds, reptiles and unique plants. Throughout the island, wildlife declined as habitats disappeared, isolating animals in smaller and smaller patches of forest and wetlands. The large lemurs, tortoises and elephant birds were avidly hunted.

Within 600 years of the arrival of the Malagasy, extinctions claimed many native animals. Several elephant bird species, the larger lemurs and many native plants vanished. Two kinds of pygmy hippos inhabited the island. The Madagascar Hippopotamuses (*Hippopotamus lemerlei*), an amphibious species, and *Hippopotamus madagascariensis*, a forest species, were both about 6.5 feet long and 2.5 feet tall, smaller than the Common Hippopotamus of Africa, which is about 10 feet long (Tyson 2000). From genetic and anatomical analysis, both seem to have evolved from the latter species (Tyson 2000). The hippos had been widely distributed and very common prior to the arrival of the Malagasy (Dewar 1984). Their bones have been found with marks indicating that they had been butchered (Tyson 2000). Both died out long before Europeans arrived. The native crocodile, whose large bones have been found, is believed by some scientists to represent large specimens of Nile Crocodiles, the species native today (Tyson 2000). It is thus possible that the crocodile survived. A large mongoose-like viverrid, *Cryptoprocta spelea*, and a very unusual aardvark-like animal, *Plesiorycteropus madagascariensis*, died out at an early date (Dewar 1984).

Prior to the arrival of humans, elephant birds had been abundant in most parts of the island, as attested by the prevalence of their bones. There were two genera, and from six to 12 species of these birds (Tyson 2000). It is likely that the flightless birds fell prey to the primitive weapons of the Malagasy and were crowded out of their habitats by livestock (Tyson 2000). The last to die out was the Great Elephant Bird (*Aepyornis maximus*), which may have survived until recent times by retreating to remote swamps. Dr. Alexander Wetmore of the Smithsonian Institution examined bones of a Great Elephant Bird unearthed in archeological excavations in the 1960s. He was amazed by their size: "The incredible femur, or thighbone, of this ponderous bird is by far the largest I have ever seen" (Wetmore 1967). Estimated to weigh at least 1,000 pounds, more than three times the weight of an Ostrich, it produced eggs larger than any dinosaur's, with a capacity of 2 gallons (equivalent to seven Ostrich eggs), 180 chicken eggs or 12,000 hummingbird eggs (Bradbury 1919, Fuller 1987). When one was X•rayed, the bones of an embryo three•fourths developed were revealed (Wetmore 1967). Something had interrupted the embryo's growth and frozen it within the eggshell for hundreds and perhaps thousands of years (Wetmore 1967).

Despite its fearsome size, the Great Elephant Bird lacked a hooked beak for tearing prey and was plainly not a predator (Wetmore 1967). Its large, clawed feet may have helped it defend itself against the small native predators but were not enough to protect it from Malagasy arrows. Its short legs prevented it from running as fast as its relative, the Ostrich, but it may have been quite agile when chased. This vegetarian bird browsed and cropped plants, able to reach with its long neck to the lower branches of trees (Wetmore 1967). By the mid-16th century, when Europeans had managed to establish a foothold in Madagascar, the new French Governor, Sieur Etienne de Flacourt, wrote in 1661 that the Great Elephant Bird was still found in the south of the island, "seeking the most deserted places" to avoid human hunters (Tyson 2000). Villagers of Antandroy told of an Ostrich-like bird that was difficult to catch, according to Flacourt (Tyson 2000).

The exact date this giant bird became extinct is not known with certainty. Alan Feduccia (1996), an eminent paleo-ornithologist, asserts that elephant birds of many species were still widespread in the 10th century but gradually disappeared as a result of human activity. He cites an account by a French merchant sailor in 1848, who visited Madagascar and saw the shell of the Great Elephant Bird; he was told that it belonged to the chief and that the bird that produced such eggs "is still more rarely seen" (Feduccia 1996). Some authorities estimate that it died out in the mid-17th century, although there is no proof that any European ever saw one of these birds (Tyson 2000). It has been suggested that Europeans were responsible for the bird™s extinction by hunting and destroying its habitat (Quammen 1996). But Thomas Brooks (2000) of the Center for Applied Biodiversity Science, Conservation International, asserted in a list of extinct birds in *Threatened Birds of the World* (BI 2000) that all the elephant birds had disappeared by 1500. In a bizarre footnote to this species' epitaph, an *Aepyornis* egg washed up on Australia's western coast in 1995. No conclusive explanation for this strange event has been put forth, although it is likely that it became unearthed from long interment by rains, and washed out to sea. Much less is known of the other species of elephant birds, which existed in a variety of sizes down to a chicken-sized species.

Lemur-like primates once lived on many continents, but nowhere had they evolved into such a great variety of species. When the Malagasy people arrived some 1,500 years ago, lemurs occupied every habitat, even marshland. A species as tall as a man must have startled the Malagasy immigrants, giving rise to legends that these animals had superhuman powers. The first French naturalists were told by the Malagasy that these primates were thought to be the ghosts of sacred ancestors of man, inspiring the genus name Lemur, the word for ghost in Latin. The Malagasy considered some lemurs sacred and punished anyone who harmed them, but most species were feared as evil demons and were killed on sight.

From their arrival on Madagascar, the Malagasy hunted the larger species of lemurs, almost all of which are now extinct. Archaeological excavations show that they formed a staple in the immigrants' diets. Such diggings have unearthed the skulls and bones of long•extinct lemurs in early Malagasy jars and kitchen middens; their heads had been split by ax-heads made from an extinct flightless bird (Jolly 1980).

In the centuries following colonization by the Malagasy immigrants, some 15 species of lemurs of eight genera became extinct (Mittermeier 1997). These extinct lemurs were, for the most part, far larger than surviving species and had evolved to fill many ecological niches. Three *Megaladapis* lemurs weighed between 90 and 170 pounds and moved slowly through the trees, feeding on foliage (Tattersall 1993). Another species, *Archaeolemur*, was about the size of a female baboon and lived on the ground (Tattersall 1993). Two *Palaeopropithecus* species weighed between 90 and 130 pounds and were sloth•like tree dwellers with flexible bodies (Tattersall 1993). These extinct lemurs had evolved many unusual means of movement and locomotion that have no parallels in living species of lemurs.

Largest of all, the massive 400•pound *Archaeoindris* was apparently a ground•dweller, moving on all fours; many of its anatomical characteristics are unlike any living primate (Tattersall 1993). One entire lemur family, Archaeolemuridae, was obliterated. In this family were many species of lemurs weighing between 35 and 55 pounds; they were powerfully built and short•legged (Tattersall 1993). The heaviest lemur surviving today, the Indri (*Indri indri*), weighs only about 15 pounds (Tattersall 1993). These lemurs had survived for millions of years, and their extinctions were indeed a major biological loss to the planet. According to primatologists, the surviving lemurs

resemble the very earliest primates from the Eocene (Tattersall 1993). Like prosimians in Africa and Asia, but to a far greater degree, lemurs have a highly developed sense of smell. Some species have long, fox-like noses (Preston-Mafham 1991). Genetic analysis of their DNA has revealed that all lemurs are descended from a single ancestor that probably arrived from Africa about 60 million years ago (Garbutt 1999).

The Giant Aye-aye (*Daubentonia robusta*) lemur was somewhat larger and 2.5 to 5 times heavier than the surviving Aye-aye (see below), but in other respects was very similar (Garbutt 1999). It is known from subfossil remains found in southwestern Madagascar (Nowak 1999). The date of its disappearance is unknown but may be fairly recent.

Archaeologists have uncovered remains of a massive bird of prey, the Malagasy Crowned Eagle (*Stephanoaetus mahery*), which undoubtedly preyed on lemurs (Feduccia 1996). In fact, at one locality the diet of this eagle, based on the bones of eagles and lemurs found together, contained at least 80 percent primates, including specimens weighing up to 26.5 pounds (Feduccia 1996). Remains of another large eagle of the genus *Aquila* have been discovered, and it, too, preyed on large lemurs and became extinct after the arrival of the Malagasy. These extinct birds preyed on smaller lemurs as well, including some species still surviving (Feduccia 1996). A bird of prey flying overhead still elicits fear in lemurs, causing them to seek cover. Neither of the two remaining species of eagles on Madagascar preys on lemurs, but two hawk species have been seen preying on young lemurs (Garbutt 1999).

In addition to the Giant Elephant Bird, the large Snail-eating Coua (*Coua delalandei*), a member of the cuckoo family, became extinct. The last specimen of this large, slate-blue bird was taken on an islet off the east coast, Ile Sainte-Marie, in 1834 (Morris and Hawkins 1998); reports by observers who claimed to have seen the bird were recorded as late as 1930 (Fuller 1987). The causes of this bird's disappearance, and even its exact range, remain obscure (Langrand 1990). Many specimens of this bird were taken before its extinction and kept in museums in Leiden; London; New York; Paris; Philadelphia; Tananarive (Madagascar); and Cambridge (Massachusetts) (Fuller 1987). The long feathers of this bird were highly valued by the Malagasy, and hunting may have reduced its numbers to a critically low level (Fuller 1987). It is also possible that the many birds killed for zoological specimens may have pushed this already rare bird to extinction, since its distribution may have been limited to the tiny Ile Sainte-Marie. No reliable record exists of its presence on the main island of Madagascar, but there is hope that it might be found in lowland forest near the Bay of Antongil (Morris and Hawkins 1998). Ten closely related species of couas survive, all smaller than the Snail-eating Coua.

Madagascar Testing Quotes 2
Testing "quotes again" to see whether they are "going" to have 'slashes' added to them or not.

Endangered Species Handbook

Persecution and Hunting:

Persecution and Hunting

Roman Slaughters

The tradition of killing animals for pleasure has a long history in Asia and Europe. So popular was hunting in ancient Rome that mosaics and paintings often depicted this pastime as a heroic activity. Slaughtering animals was considered a form of entertainment, and people scoured the countryside for bears, Lions, stags and boars to pursue with spears and dogs (Attenborough 1987). As the Roman Empire grew to encompass the entire Mediterranean basin, its citizens traveled throughout the region to hunt and bring back animals to be killed in primitive contests in the coliseums of Rome and other cities. The coliseum games continued for more than 400 years in more than 70 amphitheaters, the largest seating up to 50,000 people on stone benches arranged around a central arena (Attenborough 1987).

Roman emperors curried favor with the public by upstaging their predecessors in killing more animals and producing more spectacular displays of slaughter (Morris 1990). Emperor Titus inaugurated the Roman Coliseum by declaring 100 days of celebration, during which enormous numbers of animals were speared by gladiators. On the opening day, 5,000 animals were slaughtered, and over the next two days, 3,000 more were killed (Morris 1990). The caged animals were kept underground in dungeons where they were not fed, and on the day of the festival, they were hauled in their cages onto lifts that brought them into the center of the arena. As the crowd roared with excitement, drums were beaten, trumpets blown, and the terrified animals were set loose (Attenborough 1987). Sometimes the animals were goaded to attack one another, and at other times, men armed with spears and tridents pursued them around barriers made from shrubs in imitation of hunts in the wild (Attenborough 1987). One arena hunt resulted in the killing of 300 Ostriches and 200 Alpine Chamois (Morris 1990).

Lions, Tigers, bears, bulls, Leopards, Giraffes and deer died after being tormented, stabbed and gored (Morris 1990). Big cats that had been starved were released into the ring where a human slave or prisoner of war was lashed to a post; the animals clawed at the person before they themselves were speared and stabbed by gladiators (Attenborough 1987). In some of the larger slaughters, 500 Lions, more than 400 Leopards, or 100 bears would be killed in a single day (Morris 1990). Hippos, even rhinoceroses and crocodiles, were brought into these arenas, and sometimes gladiators employed bizarre methods of killing such as decapitating fleeing ostriches with crescent-shaped arrows (Morris 1990).

The Roman audiences cheered these brutal slaughters enthusiastically as a rule, but when 20 elephants were pitted against heavily armed warriors, the screaming of these gentle animals as they were wounded caused the crowd to boo the emperor for his cruelty (Morris 1990). This did not stop their use in the games however. These slaughters virtually eliminated large mammals from the Mediterranean area. North African Elephants (*Loxodonta africana*) were exterminated, having been hunted and captured to die in these arenas (Leakey and Lewin 1995). Elephants were also used by the Romans for transport and even conscripted for battle by Hannibal, a Carthaginian general who used them in a deadly march across the Alps, in which all the elephants died of exposure. Romans were probably the key element in the disappearances of the Asian Elephant (*Elephas maximus*) from West Asia as well (Leakey and Lewin 1995).

Prior to the expansion of the Roman Empire, Atlas Bears (*Ursus arctos crowtheri*) lived in the mountains and forests of North Africa, the only bears on the African continent. Named for their last refuge in the Atlas Mountains of Morocco, they were a race of the Brown Bear which is native to Eurasia and North America. North Africa was the species' most southerly distribution. When Romans entered North Africa, they cut the forest habitat of this bear and slaughtered thousands for sport. Others were collected for coliseum combat, where they were attacked by smaller animals, or gladiators wielding axes, spears and other weapons. Over the centuries, the Atlas Mountain forests were leveled for building materials, and colonial landowners used the cleared land for grazing livestock (Day 1981). The

Atlas Bear became restricted to Mount Atlas, where an 18th century French naturalist discovered a fresh skin, upon which the first scientific description was based (Day 1981). Even as late as 1830, the bears were common enough to be captured and sent to French zoos. In 1840, an English scientist concluded that this bear, smaller than the American Black Bear (*Ursus americanus*), was a distinct subspecies. It was stocky, with a short face, blackish-brown, shaggy fur on its back, and orange-rufous fur on its belly (Day 1981). This differentiates it so much from the Brown Bear that modern taxonomists might consider the two distinct species. Although Atlas Bears became increasingly rare, they received no protection from hunting, and the last of these bears were shot around 1870 (Day 1981).

Herodotus and Aristotle, philosophers of ancient Greece, wrote that Lions once lived in that country (Attenborough 1987). Two thousand years ago, the range of these big cats extended eastward in a continuous band to India and Pakistan and throughout the African continent. The Lion disappeared at an early time from Italy and Greece after being hunted and captured by the thousands for gladiator spectacles. When European Lions had been killed off, Romans turned to North Africa. The Barbary or Atlas Lion (*Panthera leo leo*), once distributed through much of the region north of the Sahara, fell victim to hunting and Roman Coliseum games. Known for its enormous mane, which covered virtually half its body, the male Barbary Lion was one of the largest of all races of Lions (Day 1981). It was also the nominate, or first subspecies named. This massive animal weighed as much as 500 pounds and measured up to 10 feet long from the tip of his nose to the tip of his tail (Day 1981). After centuries of hunting, persecution and habitat loss, these Lions withdrew to remote forests, where the last of them were systematically hunted down. Arabian tribesmen in Tunisia and Algeria chased them for sport, and later, French colonial governments paid bounties for their skins; by the 19th century, hunters had exterminated the last of the lions in Algeria (Day 1981). Government lists recorded the bounty fees paid, with fewer each year; only one skin was submitted for payment in Algeria in 1884 (Day 1981). Their final refuge, like the Atlas Bear's, was the wilderness forest of Morocco's Atlas Mountains, where hunters killed the last one around 1922 (Day 1981). Although officially extinct, some of these Lions may still survive in captivity. Certain circus and zoo Lions resembling the original Barbary Lion have been identified, and an effort is being made to gather a breeding colony of these animals. Whether they are, in fact, direct blood lines from the original North African Lions remains to be seen.

By the 13th century, Lions had been eliminated in the eastern Mediterranean; they disappeared from Iraq, Iran and Pakistan by the 1800s (McClung 1976). The last Lion in the Saudi Arabian peninsula was killed in 1923. For most ancient cultures of the Middle East and West Asia, killing one of these great cats, especially a large male, was considered a heroic deed worthy of being recorded in paintings and mosaics. Many such art works remain from Assyrian and other West Asian cultures. By the mid-19th century, Asiatic Lions (*Panthera leo persica*) had become confined to India, but were still widespread in that country (McClung 1976). During the last half of the 19th century, however, Indian Lions came under siege by British Colonial officers, who traditionally proudly took a Lion pelt back to England; a single hunter boasted of shooting 300 Indian Lions in 1860 (IUCN 1978). Under such pressure, Lions disappeared from all of India, save the Gir Forest in the southwest, by 1884 (IUCN 1978). In 1900, protection was finally accorded the last of these Lions, when their populations had been reduced to fewer than 100 animals (McClung 1976). Today, the Gir Forest Lions number a few hundred animals, all that remain of these proud cats on the Eurasian continent. Confined to a habitat that was rapidly being whittled away by villagers cutting firewood, and overgrazed by livestock, the Gir Lions are now protected in the Sasan Gir National Park of western India where, in recent years their population has increased.

Hunting by Romans and later peoples, combined with capture for the colosseum games, devastated the wildlife of North Africa and the entire Mediterranean region. Large predators, as well as deer and other ungulates, disappeared altogether or become endangered. Few conservation programs exist to protect remaining populations from hunting and persecution.

Predator Prejudice

The Roman tradition of persecuting predators spread throughout Europe and intensified in proceeding centuries, reaching superstitious depths in the Middle Ages. Beliefs that fiwerewolvesfl existed resulted in the persecution of wolves in Europe and Russia that continues today. Fairy tales are still recounted to children, in which wolves and bears are depicted as voracious killers. These stories, especially those by the Grimm brothers, frighten small children with tales of wolves, that pursued and ate small children and adults alike. "Little Red Riding Hood" and other stories instilled horror and hatred of predators. In Russia, the destruction of wolves was considered a great benefit to people, as well, with folklore embodied in tales such as "Peter and the Wolf." Persecution of wolves in that country continues to this day. With the spread of domestic livestock throughout Europe, official programs were instituted to destroy wolves (McIntyre 1995). Wolves were not the only animals killed in these programs. Lynx and Brown Bear were also eliminated from all but the most remote areas of Western Europe.

When Europeans settled in America, they brought these prejudices with them, treating native predators as vermin. Most colonies passed laws similar to Massachusetts' 1630 law requiring that "every English man that killeth a wolf . . . shall have allowed him one penny" (McIntyre 1995), and South Carolina's 1695 "Act for Destroying Beasts of Prey," which mandated that all Native American braves be required to bring in one skin of a wolf, panther, or bear, or two Bobcat skins each year. If he failed to do so, he would be "severely whipped," but if more than one skin was provided, he would receive a reward (Nowak 1972). In the East, these programs systematically killed off Gray Wolves, bears and Cougars. Large predators were effectively eliminated in the eastern states by the early 1800s, except for the Black Bear, which became greatly reduced in range and numbers.

The US government ran predator control programs throughout the country. Traps and poisons were the major tools used. Poison was liberally spread over most of the West. Thallium sulfate, strychnine, Compound 1080, and cyanide were distributed in great quantities, killing not only wolves, bears, and Coyotes, but foxes, weasels, ferrets, eagles and other birds. Any animals that ate the poisoned bait died, as well as those feeding on their carcasses. All these poisons caused a painful death, and most killed slowly. Poisoned animals could take hours to die from Compound 1080, and sometimes days after ingesting thallium sulfate. Strychnine, an extremely painful poison, can make water supplies lethal, killing humans, dogs and livestock. The wild predators that consumed Strychnine would vomit while dying from convulsions. Their bodies spread more poison, which remained toxic for a year or more.

Trapping was equally indiscriminate in its victims. Irrational prejudices against predators resulted in the total extermination, even in remote wilderness areas, of America's wolves and almost all its bears through bounty systems, federal subsidies and government control programs. Trappers and poisoners combed the countryside, randomly placing poison and traps.

Prejudice against predators affects a wide spectrum of animals, from foxes and bears to bats and birds of prey. Although the number of species that have become threatened as a result of control programs and random killing is less than those threatened by habitat destruction, the ecological consequences have affected a host of species within their habitats. These animals have co-evolved with their prey, the wolf making the deer fleet; wild cats making gazelles, zebras and hundreds of other ungulates agile. Although there is dispute as to the effect that predators have on the populations of their prey, overpopulations of deer and other ungulates have occurred in many parts of the world where predators have been eliminated. When ungulates overpopulate, they tend to overgraze their habitats, eliminating many types of vegetation, as well as birds and other wildlife dependent on that vegetation for feeding and habitat. Thus, thousands of species may be adversely affected when predators are destroyed.

Many species of snakes, as well as small carnivores such as foxes, eat large numbers of rodents, performing

important roles in preventing population explosions of these prey animals. Bats, as the most important predator of insects, control insect populations, as documented by many scientific studies. These mammals, although more abundant in number and diversity than carnivores, have declined radically in recent years, as evidenced by the enormous number now listed in the *2000 IUCN Red List of Threatened Species*. From a humane point of view, predator control has brought out the worst in human character, suppressing reason and compassion to allow fear and hate to dominate. As science has learned more about the importance of predators, and they are being protected and reintroduced in a growing number of areas in the world, prejudices remain, as do centuries-old ways of raising livestock that involve killing predators. These latter problems need to be addressed with the same vigor that has elevated predators to their rightful place at the top of their food chains in the eyes of conservationists and scientists.

Wolves, Wild Dogs and Foxes

Wolves have suffered more inhumane treatment and loss of range and populations than any other predator. The history of their survival and disappearance in various parts of the world is a reflection of the overwhelming importance of people's attitudes toward animals. When emotions, especially fear and negative superstition, rule people's minds, wolves can be destroyed on the basis of ignorance about their real threats to people and livestock. On the other hand, when people are aware of biological facts about the wolf and its ecological role, behavior, value to ecosystems, and the truth about its history of not attacking people, prejudices tend to dissipate. Native Americans had a natural affinity and respect for wolves, calling them "brother." The wolf's very survival as a species depends on its being treated with tolerance and respect. Gradually, this is happening in many parts of the world. Education and a change in government attitudes in many countries are needed to conserve this species, along with better ways of raising livestock.

Wolves, Wild Dogs and Foxes: Page 1

Prior to European settlement of North America, two wolf species lived throughout the forests of the East: the widespread Gray Wolf (*Canis lupus*), the same species that is native to Eurasia, and the Red Wolf (*Canis rufus*), a uniquely American species of the Southeast. Some biologists estimate that there were 2 million wolves on the continent at this time. European settlers entered the American wilderness and set about killing off these animals. The book, *War Against the Wolf. America's Campaign to Exterminate the Wolf*, by Rick McIntyre (1995), chronicles the history of this extermination program, based on historical and modern documents. Colonists dug pit traps and filled them with vertical stakes, which impaled wolves falling onto them. When hunters found an animal in the pit, they would leap in and ham-string the cowering wolf. John James Audubon described a farmer who captured wolves in a pit trap, severed the tendons in their hind legs, then tossed the crippled animals into a pack of dogs which tore them

apart (McIntyre 1995). The new colonists and their professional hunters set toothed traps that held the animal's leg while the teeth broke through its skin, wounding and breaking bones. Some who captured wolves cut off the lower jaw and turned the animal free to starve (Laycock 1990). Others set them afire, or started forest fires to rid the woods of wolves (Laycock 1990). Strychnine and thallium were placed in meat baits. Wolf pups were ripped apart by dogs, stomped to death, or burned alive in their dens. One predator hunter threw baited fish hooks, attached to lines, into wolf dens, waited until the pups swallowed the hooks, which embedded in their stomachs, then dragged them out of the den and killed them (McIntyre 1995).

Europeans were convinced that wolves hunted humans, even entering towns to kill children as they slept. In truth, wolves are neither ferocious nor killers of people. No case of a non-rabid North American wolf killing a human has ever been documented (McIntyre 1995, Nowak 1999). Very passive when trapped, they do not even attack the trapper as other predators might. Native Americans took wolf pups out of dens for pets without ever being attacked by the parents.

Red Wolves, named for their reddish-brown coats, had other color phases as well. Prior to their near-extinction, they exhibited a range of colors from black to gray and brown. The genes for these color phases were eliminated along with the wolves themselves in predator-control programs. Originally, this wolf inhabited the United States as far west as Oklahoma and eastern Texas, north to Indiana, as well as the southeast. The Red Wolf is the only surviving wolf that evolved in North America. This species and its ancestor, *Canis edwardii*, had been resident in forests as far north as Pennsylvania since the middle Quaternary epoch (Nowak 1979). Dr. Ronald Nowak, an expert on wild canids, maintains that the Red Wolf is a far more ancient species than the Gray Wolf. The latter species is thought to have evolved more recently in Eurasia, during the early Pleistocene, and migrated into North America across the Bering land bridge that linked the continents (Nowak 1979).

Weighing only 20 to 40 kilograms (44 to 88 pounds), and 660 to 790 millimeters (26 to 31 inches) tall at the shoulder, the Red Wolf is larger than the Coyote (*Canis latrans*), but smaller than the Gray Wolf. Mating for life, it breeds in February or March, producing two to six pups in March or April. The pair dens in hollow logs or along banks of canals or ditches. These wolves did not usually form packs, but were most often seen in pairs or small family groups. They were systematically trapped, shot and poisoned out of their range. From the 17th century onward, in state after state, these wolves were exterminated to the last animal, pushing this species toward extinction. Federal predator-control programs took some 50,000 Red Wolves from 1937 onward, until they were virtually extinct in the wild (Laycock 1990). It was not until 1962 that this wolf's highly endangered status received any attention from biologists and wildlife officials. Still, no action was taken to stop state trapping and predator-control programs for another 11 years.

By the 1970s, the Red Wolf had been completely exterminated, except a small population that survived in one county in southwestern Louisiana and in adjoining areas of eastern Texas (Carley 1975). Coyotes had moved into the range of the Red Wolf and interbred with some of the last members of the species. This hybridization spelled the demise of wild Red Wolves. It has been suggested that this interbreeding occurred only because Red Wolves had become so rare that they were unable to find mates of their own species. A live-trapping program to capture the last, pure-blooded specimens, as the only way of saving the species, began in 1973 in Texas, funded by the US Endangered Species Act (ESA). Fewer than 100 animals remained. After capture, X-rays were taken of these animals' skulls to determine which were pure-bred and which were hybrids, based on their skull shape and dimensions.

A number of these hybrids, as well as the pure-blooded Red Wolves, were in poor health from mange, heartworm and other parasites when captured (Carley 1975). Their last attempt to survive in the wild had obviously been a difficult one. Their remaining habitat in Texas and Louisiana had become a mosaic of agricultural and residential development, leaving little natural forest. Moreover, they were under constant threat from trappers and hunters. After five years of live-trapping, only 40 pure-blooded Red Wolves were identified, and they were sent for captive breeding at the Point Defiance Zoo in Tacoma, Washington. No further Red Wolves were found, and in 1979, Howard McCarley and Curtis Carley of the Red Wolf Recovery Team, authorized under the US Endangered Species Act, announced in a status

report, "Recent findings indicate that the only extant subspecies (*Canis rufus gregoryi*), once occurring from eastern Texas to eastern Mississippi, for all practical purposes is extinct in the wild" (McCarley and Carley 1979). The other subspecies of the Red Wolf, the Florida Red Wolf (*Canis rufus floridanus*), had become extinct by 1917 (Day 1981). So many wolves of the Florida race, which once ranged into Georgia and southern Tennessee, were black, that this wolf was originally named the Black Wolf. This genetic strain is now lost.

Of the 40 captive Red Wolves, 14 were selected to form the nucleus of a Fish and Wildlife Service-sponsored captive-breeding colony (Nowak 1999). In 1977, offspring were successfully produced, and by 1989, there were 83 descendants, and the last surviving wild-caught Red Wolf died (Nowak 1991). In 1993, the captive colony consisted of more than 187 animals in 31 breeding facilities. By 1995, there were 289 living descendants from the original wild Red Wolves, the majority in Point Defiance Zoo in Tacoma, Washington (Nowak 1999). In the mid-1980s, reintroduction programs began with the release of several of the captive-bred wolves to the wild. This was the first time the American government had ever sought to introduce and protect wild populations of wolves, instead of eliminating them. Since the Coyote is now present throughout the Red Wolf's original range, attempts were made to find reintroduction areas without Coyotes to prevent hybridization and competition. In 1987, four pairs of Red Wolves were reintroduced into the 120,000-acre Alligator River National Wildlife Refuge, an island in North Carolina without resident Coyotes. A pair released on Bulls Island in Cape Romain National Wildlife Refuge in South Carolina produced two pups in 1988. These pups were captured and released in the Alligator River Refuge in 1989. Another pair, introduced to Horn Island off the Mississippi Coast, produced seven pups in May 1989. By the close of 1993, 46 to 60 animals survived in these newly wild populations by Fish and Wildlife Service counts.

In 1991, a pair of Red Wolves and their two pups were set free in Great Smoky Mountains National Park in Tennessee. Jan DeBlieu, a writer on endangered species, witnessed the release of the wolf family (McIntyre 1995). This area has resident Coyotes, which arrived in the mid-1980s, and the interaction between the two species will be closely watched. Several Coyotes and the adult Red Wolves have radio transmitters and were tracked by a number of biologists after their release. DeBlieu was present when, soon after their release, the male and pups traveled 2 miles away from the female, who lay quietly in a field. Suddenly the researchers heard the prolonged, low howl of the male wolf and high-pitched yaps of the pups, a song "not heard in the Smokies for one hundred years" (McIntyre 1995). They were calling the female, who ran toward them. This national park receives 8.6 million visitors a year--more than any other park in the system. The visitors tend to stay near roads, however, and most of the park is roadless wilderness. Prey is abundant, and both the adults and pups began catching rodents and rabbits, hunting at dawn to avoid tourists during the day (McIntyre 1995). By late summer 1994, there were seven Red Wolves in Great Smoky Mountains National Park. Two more family groups were released the following year, but the available prey in Great Smoky Mountains National Park is limited in the mountainous terrain (Rancourt 1997). As many as 26 wolves lived in the park in 1997 (Rancourt 1997). A few pairs have produced young.

For the most part, these reintroduced wolves have survived with few conflicts with local people, mainly due to the extensive education programs and hearings held by the Fish and Wildlife Service in each area prior to releases. Some private landowners in North Carolina became apprehensive about the potential threat to children and livestock. The Fish and Wildlife Service has paid claimants for losses even when no proof was submitted that it was, in fact, a wolf at fault. One livestock owner admitted that the Red Wolves had become "good neighbors." Yet even these limited reintroductions have provoked resentment in some local communities which harbor ancient prejudices about wolves. The North Carolina state legislature passed a law early in 1995 that defied the US Endangered Species Act, allowing people to kill wolves that attacked livestock. The Fish and Wildlife Service accommodated these concerns by changing its policy in April 1995 to allow killing of Red Wolves thought, but not proven, to be attacking livestock in North Carolina and Tennessee. One of the first wolves killed, male number 464, was shot in 1995 in North Carolina by a landowner who caught him digging under his dog's pen. This wolf had been released the previous year near Alligator River National Wildlife Refuge, but prey was scarce, so Fish and Wildlife Service personnel recaptured him and freed him on the mainland. Number 464 had not been guilty of preying on livestock.

Further incidents between residents and Red Wolves occurred in 1997 and 1998, with wolf pups that were attempting

to disperse into new territory being trapped. One young wolf that had been taken in a leghold trap in North Carolina was rescued by the Fish and Wildlife Service and returned to a penned enclosure in 1998. The local county representative stated that wolves were unwanted intruders and would be dealt with by residents. This does not bode well for reestablishment of these wolves.

If the Red Wolf survives this irrational prejudice, it may reoccupy many of its original haunts. The threat of hybridization with the Coyote will remain, however, and without corridors of habitat to link reintroduced populations, these wolves risk becoming inbred. With education of the public, one day the Red Wolf may be restored as a natural predator, benefiting its prey and ecosystem.

Wolves, Wild Dogs and Foxes: Page 2

Unlike the Red Wolf, Gray Wolves traveled in large packs in the Great Plains of the West. Many of the wolves painted by George Catlin, the great 19th-century artist of Native Americans and wildlife of the Plains, were beige or pure white, as are many of the wolves of the grasslands of northern Canada. Early hunters killed wolves for their pelts by trapping, poisoning and shooting. Many were used for target practice in the open country. When livestock ranchers took over huge tracts of land in the West, the Gray Wolf became a target for total extermination. Cowboys often roped wolves and dragged them to their deaths across rough ground (McIntyre 1995). Federal trappers used even more brutal killing methods (McIntyre 1995).

James Josiah Webb, who wrote a memoir of events in the Santa Fe, New Mexico, area from 1844 to 1861, recounted that two men conducted a wolf-killing operation by spreading strychnine bait placed in chunks of bison meat around the prairie. The number of wolves that once inhabited the region was so dense that they found 64 dead wolves within 1.5 miles of their camp in a single day after a poisoning; they bragged that they earned $4,000, an enormous sum in those days, by selling wolf pelts (McIntyre 1995).

As wolves were exterminated in one state or territory after another, a few of these intelligent animals managed to escape traps, guns and poison, earning the label of "outlaws." These wolves ranged alone or in small packs, and in the last days of the western wolf, some trappers spent months or years in determined pursuit of them. The ability of these wolves to elude their persecutors were truly amazing. One of the most famous such cases was described by Ernest Thompson Seton, an English artist and writer, in *Wild Animals I Have Known* (1899). Based on fact and documented by photographs, it concerned Lobo, an enormous wolf, called "The King" by Mexican residents who lived near a huge cattle ranch in northern New Mexico. For many years in the 1890s, Lobo led a pack of five wolves. He had a distinctive, deep howl that ranchmen recognized among the howls of the other wolves. He was by far the largest wolf in the pack and exceeded the size of other wolves in the region. Whereas most wolf paws measured 4 3/4 inches, Lobo's were 5 1/2 inches long. His mate, whom the Mexicans called Blanca, was a large, magnificent white wolf.

These wolves, like many others of the West during this period, had been deprived of their natural prey, White-tailed and Mule Deer and Elk, which had been hunted out by settlers and replaced with livestock. The wolves turned to livestock as the only large prey available and, in doing so, became the target of ranchers' wrath. Western ranchers, like many livestock owners in Europe, believed that they should be able to release cattle to roam free without herding them into shelter at night. This situation had existed in Western Europe after large predators were eliminated from all but the most remote areas. In their new ranches, allocated to them by the government, ranchers sought to recreate the European model. This required the destruction of large predators.

Lobo and his pack refused to eat dead animals that they encountered, apparently to avoid poison, and survived on calves and sheep that they killed themselves. When Lobo and his pack killed a cow, ranchers immediately put poison in the carcass. But when the wolves returned the next day to eat, they somehow knew which parts of the carcass were

poisoned, and pulled out the poisoned chunks, throwing them aside, eating only the unpoisoned portions. Lobo also avoided the traps set for him and hid from hunters on horseback who pursued him. Trappers came from great distances to claim the high bounty on Lobo, but all failed to kill him. Ernest Thompson Seton decided to try to kill Lobo himself for the $1,000 bounty. He scattered poisoned baits, covering the human scent with other odors, and the following day, found that one after another of the baits was gone. Assuming that he would come upon the body of Lobo, he was surprised to find his five baits in a pile. Lobo had picked them up, one after another without eating them, and left them as a message to Seton. Seton obtained special steel jaw leghold wolf traps and set them in concealed places in Lobo's territory. When he came out to check the traps, he found Lobo's tracks leading from trap to trap. The canny wolf had discovered each of the traps during the night, scratching earth away to reveal the chain and trap, continuing from trap to trap until he encountered one in the center of the trail. Lobo then retraced his steps, placing each paw exactly in its old track until he found no more traps, using his paw to flip stones and earth clods to spring every trap.

Seton finally succeeded in trapping Blanca by setting hidden traps among parts of a cow carcass and covering the area with Coyote scent. Lobo avoided the traps, but Blanca made a fatal error and blundered into one. When Seton and the others found her dragging the heavy trap, she turned to fight, howling across the canyon. Lobo howled back, while Seton and the others brutally killed her. Throwing lassos over her neck and holding the ends of the ropes, they galloped horses in opposite directions until her body was torn apart. When he wrote of the event years later, Seton (1899) called the killing a tragedy. They heard the howls of Lobo for days afterward. Seton described it as having "an unmistakable note of sorrow in it, now. It was no longer the loud, defiant howl, but a long, plaintive wail." When they found Lobo's tracks at the spot where Blanca had been killed, Seton reflected, "Now, indeed I truly know that Blanca was his mate."

Soon afterward, Lobo came near the ranch house. His tracks showed that he had galloped about in a reckless manner before he blundered into a trap set in a pasture. He was able to pull out of it, but Seton then set 130 steel jaw leghold wolf traps in groups of four on every trail leading into Lobo's home canyon, and dragged Blanca's body around the area to leave her scent. He even removed one of her paws, with which he made a line of tracks on the soil covering each trap. Within days, Lobo was caught with all four legs in a trap set, having followed Blanca's scent and forgetting all caution. When Seton approached the trapped wolf, Lobo managed to stand, in spite of severe injuries, and howled his deep call, but no members of his pack responded. Seton and others wrapped ropes around his neck, put a stick in his mouth and lashed his jaws closed. His feet were tied, and when he was placed on Seton's horse, he refused to look at any of his captors. At the ranch, Seton placed a collar around his neck, secured him to the pasture with a strong chain, and Lobo lay calmly, gazing across the prairie.

When Seton came out the next morning, Lobo was dead. On measuring his body, Seton found that Lobo weighed 150 pounds and was 3 feet tall at the shoulder. He was one of the largest wolves ever trapped in the Southwest. The largest Gray Wolves are native to northern Canada and Alaska and weigh up to 176 pounds, but most wolves of the Southwest were far smaller and lighter (Nowak 1991). Scientists who measured the skulls of the pair estimated that Lobo was 4 to 5 years old when he was killed, and Blanca was 7 (McIntyre 1995). Photos of Lobo and Blanca caught in traps are reproduced in Rick McIntyre's 1995 book, *War Against the Wolf*. Lobo and Blanca were exceptional specimens, and their slaughter represented an irreplaceable genetic loss. The treatment they received will remain a blot on human "kind." Lobo was killed on January 31, 1894, near Currumpaw, and his pelt is kept at the Ernest Thompson Seton Memorial Library and Museum at the Philmont Scout Ranch near Cimarron, New Mexico (McIntyre 1995). This experience changed Seton's attitude, and he expressed strong feelings of guilt in his description of his treatment of these wolves.

Government programs did not reflect Seton's newfound sympathy for wolves. In fact, predator-control programs intensified in the early years of the 20th century. Ranchers convinced the federal government to launch an all-out attack on predators, primarily wolves. The Forest Service and the Bureau of Biological Survey used poisons and traps to kill adult animals and many cruel methods to kill the pups in dens in their efforts to try to exterminate the wolf. In 1907 alone, the Forest Service killed more than 1,800 Gray Wolves and 23,000 Coyotes, among other animals

(Laycock 1990). After the US Congress authorized the first substantial appropriation for hiring government hunters in 1915, federal wolf-control programs achieved an unprecedented level. Hundreds of agents combed the most remote wildernesses, spreading poison even where no cattle or livestock grazed. A point system was established; the highest number of points, 15, was accorded for killing a Mountain Lion or a Gray Wolf (Laycock 1990). Hired hunters earning high point totals made the Honor Roll, while others might be fired; they were expected to kill virtually every predator in their assigned area (Laycock 1990).

Within a few decades, many thousands of Gray Wolves had been killed. They were eliminated from more than 95 percent of their range in the lower 48 states by the 1930s (Robbins 1997). A few wolves, using their intelligence and survival senses, managed, like Lobo and his pack, to survive somewhat longer, but they were killed in the end. The Custer Wolf, a large female also known as "Old Three-Toes" because she had lost a toe in a steel jaw leghold trap set by a government trapper, became as infamous as Lobo and Blanca. After her mate and pups were killed, the Custer Wolf survived until caught in a trap that became snagged on rocks (McIntyre 1995).

Vernon Bailey, a biologist with the US Biological Survey, the government agency that later became the Fish and Wildlife Service, conducted wildlife and plant studies as well as predator-control programs. He noted early in the century that the Biological Survey had conducted "the most systematic and successful war on these pests ever undertaken" (McIntyre 1995). The loss of virtually all wolves in the vast area encompassing the lower 48 states may be the most devastating predator-control campaign in history.

If not for the fact that the predator-control programs of the territorial and provincial governments of Alaska and Canada did not succeed in totally exterminating the wolf, the species might be extinct on the continent. Although wolves were persecuted and trapped for their fur in the latter areas, they survived in the far north and in the eastern forests of Ontario and Quebec and have now reoccupied most of their original range in Canada.

The Gray Wolf is able to adapt to a wide variety of habitats and climates, whether searing deserts, shrublands, grasslands, forests of all types, frozen tundra or even marshlands. It had the largest range of any terrestrial mammal on Earth, other than humans (Nowak 1999). Wolves had lived for thousands of years on the continent, their environment and prey altering drastically through the Ice Ages, needing only the presence of large prey to survive. Wolf intelligence, in fact, exceeds that of the domestic dog, which has a brain 31 percent smaller (Busch 1995). In spite of the wolf™s survival abilities, the fragmentation of packs by predator-control agents prevented them from hunting normally and hastened their disappearance soon after control methods began. This need to live in a pack for hunting and companionship made the species vulnerable to extermination. When persecuted, Gray Wolves do not desert one another, and many cases have been documented of wolves sacrificing their lives in an effort to save a pack mate. This altruistic trait also contributed to their extermination. The traits that humans most admire about domestic dogs were inherited from the wolf--loyalty, intelligence, playfulness and affection. Wolf pups were first domesticated by hunter gatherers tens of thousands of years ago, and even after selective breeding by humans in the intervening centuries, they still retain many of the wolf's best qualities.

Wolf packs have a lead pair, known to biologists as the alpha male and female, who are the only members of the pack that produce cubs. They mate for life, and dominate other wolves in the pack. They are usually the fittest and largest. Other pack members challenge for leadership, which can result in a change in the alpha pair. The entire pack, which includes adult females and males and pups from the previous year's litter, cares for the pups, ensuring that the strongest pass on their genes to future generations. Young unmated females and males "baby-sit" the pups when the alpha pair and the rest of the pack are out hunting. When the pups are about six weeks old, their baby-sitters spend hours with them in wrestling matches, games of tag and other rambunctious activities. Within the pack, wolves are extremely friendly and devoted to one another, barking and yipping with delight on meeting, and before and after hunts. They howl at night, communicating with other wolf packs which howl back. Bonds between wolves, especially mated pairs, are very strong, as illustrated by the saga of Lobo and Blanca, and many other cases of wolves in apparent mourning for lost mates have been documented. For many days, one male Mexican wolf, howling plaintively, followed a government trapper who had killed the wolf™s mate and carried off her pelt.

Other species of canids show similar behavior. The African Wild Dog (*Lycaeon pictus*), a highly endangered wild canid, hunts on the African plains in even larger packs than Gray Wolves, numbering up to 26 animals, yet only one female in the pack has pups. The alpha female might have 16 pups, and if another female in the pack has a litter, the alpha female will steal the cubs and nurse them, even if the litter size reaches 20 or more. Fewer than 5,000 of these beautiful animals, sometimes called Painted Wolves because of their black-and-yellow spotted coats, remain in the wild, and they are in steep decline (Nowak 1991). In Zimbabwe, where there are only about 300 to 500 animals, they are still persecuted by farmers. Even in national parks, they often lose prey when chased off by Spotted Hyenas or Lions.

The ecology of the Gray Wolf has been studied since the 1940s, revealing it to be completely different from the prejudicial folklore of Europe. Adolph Murie, one of America's greatest biologists, conducted studies of wolves in Mount McKinley (now known as Denali) National Park, where they were neither persecuted nor hunted. In his study, *The Wolves of Mount McKinley* (Murie 1944), he revealed: "It appears that wolves prey mainly on the weak classes of sheep, that is, the old, the diseased, and the young in their first year. Such predation would seem to benefit the species over a long period of time and indicates a normal prey-predator adjustment in Mount McKinley National Park." By examining the carcasses of Caribou and other mammals killed by wolves in the park, Dr. Murie found that most were in poor physical condition. Wolf packs test their prey by isolating and then chasing individual animals to detect weaknesses, and the majority of their chases do not result in a kill.

In spite of more than 50 years of biological studies of wolves that have shown them to be a positive rather than a negative influence on their prey, there are still many who disagree. Predator-control programs have been authorized in Alaska, Canada and parts of Eurasia in misguided attempts to protect deer, Elk, Moose, American Bison and Caribou. A trophy hunting organization, Safari Club International, paid the British Columbia government to kill wolves in that province (Williams 1991). The real motivation for these eradication programs is often to promote artificial increases in populations of ungulates, such as Moose, Caribou and deer, for sport hunting.

Over the ages, prey species of wolves have evolved to survive their attacks by becoming faster and stronger. The largest and healthiest deer on the North American continent have been found in areas where wolves are resident predators. The number of wolves in a pack varies according to the size of the prey: packs of up to 15 are needed to bring down bison, while packs of seven or fewer hunt deer (Nowak 1999). Wolves hunting large prey run in shifts, with tired members of the pack replaced by rested wolves. They will sometimes need to run for many miles after Caribou, Moose, American Bison or deer before they succeed in singling out one they are able to bring down; an average of only one in 10 chases is successful. Native Americans have always been aware of the important relationship between the wolf and its prey. The Keewatin Inuits have an ancient saying: "The caribou feeds the wolf, but it is the wolf who keeps the caribou strong" (Busch 1995). The healthiest members of each prey species are able to fend off wolf packs, and only in unusual circumstances can wolves kill them. For the vast majority of prey species, wolves sense weakness in their prey, evidenced by body stance, uncoordinated movements, the smell of wounds or, most often, by their lack of endurance when being chased (McIntyre 1995).

When wolves are hunted out of an area with deer and other ungulates, the latter animals often increase in numbers to such great levels that they strip their habitat of vegetation. The overpopulation of White-tailed Deer in many parts of the northeastern United States, especially in suburban locations, has resulted from a lack of natural predators. Their absence has created a major imbalance in eastern forest ecosystems, where they have become so numerous that they consume young trees and new growth on mature trees.

Wolves, Wild Dogs and Foxes: Page 3
Although Gray Wolves were completely eliminated from the eastern states south of Canada and east of Minnesota by 1930 (McIntyre 1995), a few remnant populations survived in northern Minnesota and northern Montana. The first US Endangered Species Act in 1967 listed all wolves in the lower 48 states and Mexico as Endangered. In 1973, another Endangered Species Act was enacted, replacing the 1967 Act. Five years later, the category for the wolves of Minnesota was changed to Threatened. In subsequent years, wolves were reintroduced to the southwest, Wyoming, Montana and Idaho, listed as Threatened experimental populations. All other wolves south of Canada are still listed as Endangered. Wolves have wandered from Minnesota and south from Canada to neighboring Wisconsin and Michigan, with about 50 wolves living in each state (Nowak 1999). Prior to eradication programs beginning in the 19th century, between 9,000 and 16,000 wolves were estimated to have occupied these three states (Savage 1996). Bounty programs killed 150 wolves a year in Minnesota alone between 1949 and 1954, and this state did not withdraw its bounty until 1965; Wisconsin stopped bountying wolves in 1957, and Michigan in 1960 (Savage 1996).

The wolves of Minnesota have gradually increased in range in the past 30 years, but they remain thinly distributed in the northern portion of the state. State regulations allow them to be killed if found preying on domestic livestock, with little or no proof of depredation. Minnesota has a compensation program for livestock owners but does not attempt to relocate wolves, even though depredations have occurred on only 1 percent of farms in that state (Savage 1996). In Wisconsin, large areas have been closed to Coyote hunting during the deer season, which has greatly decreased wolf mortality there, since many wolves were shot--either mistakenly or intentionally--by hunters (Savage 1996). Unlike Minnesota, Wisconsin relocates wolves found preying on livestock and compensates owners of livestock killed by wolves; Michigan's Upper Peninsula, where wolves are found, has no livestock (Savage 1996).

Although many Minnesota residents consider wolves to be threats to livestock and resent the protection they receive from the US Endangered Species Act, for others, they are a thrilling symbol of wilderness and the America that existed several hundred years ago. Ellen Hawkins and her husband Gary live in a wilderness cabin surrounded by Superior National Forest land, prime wolf country in northern Minnesota. Because they are avid wildlife watchers, they put out food for birds, foxes, Fishers, Martens and weasels, and state officials bring the couple road-killed deer which they place in a clearing 200 yards below their house for wildlife to feed on. They saw wolves very rarely and felt lucky to hear their howls or find their tracks (Hawkins 1988). One December day, they spotted a wolf feeding on a deer carcass on their property and noticed that he was wearing a radio collar, placed by the Fish and Wildlife Service to track many of Minnesota's wolves.

Their excitement at seeing the wolf, who brought "magic to the place," dimmed when they realized he was injured. He limped, holding up his right front foot, and they saw him fall in the snow (Hawkins 1988). He kept his tail down, a sign of subservience and fear, and moved stiffly and awkwardly. He spent five days feeding on the deer, lying in the snow near it, and seemed weaker each day. On the sixth day, he disappeared from the clearing, and in the middle of the night, an amazing event occurred: "We were confronted by his face pressed against our window" (Hawkins 1988). As they stood gaping at him, they heard him thump his nose on the glass, still staring at them. The wolf then went to another window, and they found themselves again eye-to-eye with him. He had climbed a snowdrift onto their greenhouse roof and now sat leaning against the window, looking back over his shoulder at them. The Hawkinses found some chicken and tossed it onto the roof next to him, while offering him a pan of gravy. The wolf looked at the food, and then at them, but did not eat.

The temperature was 25 degrees below zero F., and they decided the wolf needed warmth. Gary got a blanket and put it around the wolf, who jumped at first, and then quieted down. His passive response made them think that he should be brought indoors. They got an old quilt, and Gary picked up the sick wolf, carrying him into their living room. The wolf was somewhat dazed, but hardly moved. They called their neighbor, who came 12 miles to see the frail and sickly wolf sitting near the stove in their living room. Uninterested in food, the wolf looked about and seemed to warm up, leaning against the stove until his fur singed. They saw that he had lost part of his front foot, and they heard him wheezing as he breathed. Within minutes, his condition deteriorated, and he began pawing at his mouth. His wheezing grew into a "terrible, deep gurgling" (Hawkins 1988). Gary moved close to the wolf and began to stroke its

head. The wolf stood up with effort, but then slumped down to lie beside the stove. Gary removed the collar so that the wolf could breathe more easily, and they saw that it had a number--6530--with the address of the Fish and Wildlife Service. The wolf suddenly staggered into the middle of the room, spasmed and struggled for breath. Gradually they saw his eyes become unfocussed, and the light faded out as he died (Hawkins 1988).

They later learned that Wolf 6530 left his pack when he was nearly 2 years old and wandered for eight months before he returned to his family. He stayed with them only two months before walking 40 miles to another hunting area. Finally, fatally ill, he came to the Hawkins' house, which was 45 miles from his pack. An autopsy revealed that he had died of a fungal pneumonia, the first such case of wolf mortality. The disease may have been brought on by stress and lack of nourishment (Hawkins 1988). Although his coat was thick, he was emaciated, weighing only 55 pounds. At his age he should have weighed at least 75 pounds. He had a tear on his lower lip, had lost three pads on his right foot, and one pad was mutilated on his left foot (Hawkins 1988). A biologist with the Fish and Wildlife Service was contacted about Wolf 6530 and, in his opinion, the wolf's foot wounds were probably the result of getting caught in a fox trap and dragging the trap about until its toes rotted off (Hawkins 1988). As long as he was dragging the trap, he was unable to hunt with the pack, and this may have explained why he was forced to wander in search of carrion.

Many Minnesota wolves and those dispersing to neighboring states and southern Canada have been trapped in leghold traps. In fact, Wolf 6530's brother had been killed by a trapper in Ontario, 115 miles to the northeast, at the age of 18 months (Hawkins 1988). Wolf 6530 had suffered for many months, and his life ended prematurely. Wolves can live 10 years or more in the wild. Only because he had turned to people during his last days did his story come to light. Ellen Hawkins reflected on the extraordinary event: "We'll never know what motivated him to come our way. I can only say that I'm grateful to Wolf 6530 for sharing his last, desperate moments of life. His act gave us a sense of connection with his world that we would never have had, and our commitment to live in harmony with that world has been strengthened. We will always carry with us the vivid image of the wolf at the window" (Hawkins 1988). The dying wolf may have sensed that the Hawkinses were friends of wildlife, having seen them put out food and watch him without taking any aggressive action toward him. Because he was a highly social animal who had been forced into solitude for most of his short life, he may have sought their company, sensing that he was close to death, preferring humans to an isolated and painful death without his pack mates. Whatever his motivation, his appeal to the Hawkinses' prior to dying was evidence of the complexity of this fascinating creature, and an indictment of the continued use of the inhumane steel jaw leghold trap.

Wolves, Wild Dogs and Foxes: Page 4

To counter the strong anti-wolf prejudice, a new organization called the International Wolf Center in Ely, Minnesota, has live wolves in an enclosure, museum exhibits and field classes. The 50,000 visitors it has received in the past few years brought $3 million to the local economy (Chadwick 1998). But wolves in Minnesota and elsewhere continue to be taken in traps set for other types of animals, causing injury or death. One study on wolves taken in various types of traps was published in the *Journal of Wildlife Management* (Ballenberghe 1984). It investigated injuries and mortality of 126 wolves trapped in northeastern Minnesota and Alaska. Traps used included steel jaw leghold traps of various types, some with teeth, others with smooth offset jaws; steel cable foot snares; and cable neck snares equipped with devices that prevented the loop from fully closing (Ballenberghe 1984). The results confirmed that steel jaw leghold traps caused the greatest number of injuries and mortalities: 41 percent of 109 adults, yearlings and pups caught in these traps incurred serious foot and leg injuries, defined as lacerations, damage to tissue, bone breakage, and joint dislocations (Ballenberghe 1984). Three wolves, including a pup, had broken leg bones; two others lost front feet after they were nearly amputated by the trap. One young male with broken radius and ulna bones in his foreleg was released in this study to stumble off; this wolf was caught by a trapper several months later (Ballenberghe 1984).

Other injuries resulted when trapped animals gnawed their own feet off and chewed on the traps, breaking teeth and

splitting lips. The steel jaw leghold traps caused tissue, muscle and tendon injuries, even when checked daily (Ballenberghe 1984). Since the observations carried out were not done by a veterinarian, or with aid of X-rays and other sophisticated tools to arrive at diagnoses, many unnoticed or undetectable damage to nerves, ligaments and other body parts almost certainly went undetected. Other effects of trapping noted in his study were heat and water stress; stress from risk of discovery and killing by people happening upon them; killing by other predators finding them trapped; and undiagnosed trauma (Ballenberghe 1984). In the same study, a wolf was killed by a cable neck snare when it passed over his chest and closed around his stomach. Long-term effects from broken teeth, severed tendons and poorly healed bones made survival unlikely. This was the case with Wolf 6530, described above, who suffered for many months with an injured paw after pulling free from a leghold trap, becoming weaker and weaker until he died.

Another method tested involved darting animals with tranquilizers from helicopters, which resulted in the euthanizing of a wolf after it became paralyzed when the dart penetrated its spinal column (Ballenberghe 1984). Of the animals darted, 85 percent sustained injuries and soft tissue damage. The Ballenberghe study also cited other research projects with even higher mortalities, and commented, "None of the wolf capture methods discussed here resulted in study animals that were free of injuries, but some methods clearly had more potential to inflict serious injuries than others."

The steel jaw leghold traps that Ballenberghe found to be the most injurious are the very traps that are still used by the Fish and Wildlife Service, Animal Damage Control (ADC)*, state game departments and others, killing wolves and many non-target animals. The US Department of Agriculture's Animal Damage Control program, which traps hundreds of thousands of Coyotes, Cougars and other predators for the benefit of livestock owners, has been responsible for the incidental trapping of endangered and threatened species, from Bald Eagles (*Haliaeetus leucocephalus*) to Gray Wolves.

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*Animal Damage Control (ADC) has since been changed to fiWildlife Services.fl

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Many wolves are trapped by wire snares. A loop of wire pulls tight and cuts through the skin when the animal steps into it or, in the case of a neck snare, it is placed a few feet off the ground and strangles and cuts through the flesh of an animal blundering into it. Most US states allow wire snares, and wolves are taken in them in Alaska. The Alaska Department of Fish and Game has sponsored various control programs or "studies" on wolves, using airplanes, steel jaw leghold traps and, most often, wire snares. The avowed purpose of recent state research, which involved trapping wolves in a large wildlife management area near Fairbanks, was to determine their population and effect on ungulate prey, such as Moose, Caribou and Elk. In fact, this and similar "studies" have been launched after hunters urged the state to eliminate wolves in order to leave more prey species. The rationale of the trapping program is based on the premise that killing wolves will result in increases in the population of these prey animals. A program in the 1970s involved the elimination of wolves from a 3,000-square-mile area, but according to Warren Ballard, a retired game biologist from Alaska, the Moose population did not rebound after wolves were exterminated (Egan 1992). Moreover, it creates an imbalance in the ecosystem. Killing of ungulates by human hunters does not cull the sick and old, but rather the fittest and largest.

In 1992, such a wolf "research" program, involving the setting of thousands of wire snares, was carried out south of Fairbanks. Gordon Haber, a conservationist and wolf biologist who has worked for decades on behalf of Alaska's wolves, brought television crews to film the snaring operation in December 1994. They were shocked by the scene that awaited them. Four wolves had been caught in wire snares, two of them pups. One was dead, and three were still alive, terrified and in great pain. A 6-month-old pup, with its paw caught in a neck snare, had chewed off its foreleg in a futile effort to escape. Another had been snared around the chest, causing deep wounds. The other two had been snared by the leg. All these snares had been set to catch the wolves by the neck and kill them, yet none did. Members of the pack milled about nearby, unwilling to leave their fellows. Two snared Caribou were lying dead nearby. A trapper was filmed as he attempted to shoot the wolves, repeatedly missing or wounding them because he used the wrong caliber ammunition in his gun. He shot one pup five times in the head and body at point-blank range with the

wrong gauge ammunition. The pup, wounded, remained standing. The trapper then reloaded with other ammunition, and this time shot all three wolves fatally.

The film of this massacre was shown on national news programs, causing outrage around the country. Alaska Governor Tony Knowles called off the hunt, ordered a review and stated, "That's no way to treat an animal." Six hundred and eighty-five snares set for this program were removed from state lands, but not before 12 more wolves had been killed. More than 1,000 snares had been set by the state for this "study," which lasted two years. On February 2, 1995, Governor Knowles made public the results of the Gray Wolf kill review. During the program, 134 wolves were snared, 37 of which were found alive and had to be shot. Also caught in the neck snares were Moose, Caribou, Grizzly Bears, Wolverines, Coyotes, Red Foxes, Arctic Hares, Common Ravens and Golden Eagles (AWI 1995). This gruesome haul of non-target animals is typical of the indiscriminate nature of snares.

Governor Knowles canceled the wolf kill indefinitely and ordered a review of Alaska's entire predator-control policy. This "research" program was permanently canceled in February 1995. A biologist with the Alaska Department of Fish and Game admitted in 1997, while appraising the program, that it had been ill-conceived, poorly run and politically motivated. He insisted, however, that wolves had suffered no pain from the snaring and even from chewing off their own paws. This failure to acknowledge proven neurological effects of such injuries is not unusual among state game department officials.

In 1996, the Alaska Department of Fish and Game began a new program to curtail the wolf population in the Fortymile region near Fairbanks. This time, the program consisted of sterilizing the alpha male and female of each of the 15 wolf packs in the area, with plans to relocate all "subordinate" wolves (Trost 1998). The plan to reduce all 15 packs to a single sterile pair was intended to increase the number of Caribou for hunters (Trost 1998). The Alaska Wildlife Alliance strongly opposed this project, and Gordon Haber expressed the opinion that it would reduce the wolves of the area to the brink of extinction (Trost 1998). This research program was described as "based on assumptions" by the National Academy of Sciences.

Alaska's trapping regulations are the laxest in the country, with no visitation requirement, meaning that trappers are not required, as in most states, to check traps daily for animals. Animals suffer in steel jaw leghold traps or snares for days. One case is known of a trapped Lynx--brought food by its mate--that lived for six weeks with its leg caught in a leghold trap.

No state regulations govern the manner in which trapped animals are killed, and trappers often stomp trapped animals to death to obtain pelts without damage--such as that caused by bullet holes--to the pelt. The Alaska Game Department takes advantage of the strong ties between wolf pack mates by requiring trappers of wolves to count the number of wolves in the packs of the animals they trap. Pack mates will usually remain by their trapped pack mate, even when it is dead in a trap.

Wolves, Wild Dogs and Foxes: Page 5

Aerial hunting of wolves was carried out for decades in Alaska by private parties and the Alaska Department of Fish and Game itself. Prior to 1972, wolves could be hunted from airplanes for sport, or by state predator-control agents. Federal legislation was enacted in that year to ban such hunting, with high penalties including confiscation of aircraft, large fines and even jail terms. In fact, Director of Wildlife Conservation David Kelleyhouse, known as "Machine Gun Kelleyhouse," suggested that the best way to control wolves was to machine-gun them. In 1991, a state law was passed in Alaska that allowed shooting of wolves if the aircraft landed 330 feet away from the animals. This legislation was virtually impossible to enforce. Many hunters flew over wolf packs, hazing them until the wolves were too exhausted to escape. Then they would land and kill the wolves. The law failed to protect wolves from this type of

harassment and killing. Among the misuses alleged were trappers checking their trap lines by flying from one set to another, and killing wolves and other predators they saw. Another common practice that was targeted was the "recreational" aerial hunting of wolves. Conservationists in Alaska began a petition campaign to change the law through voter ballot referendum for the November 1996 national election, having failed to persuade the legislature to enact a stricter law. This ballot was openly opposed by many members of the Alaska Department of Fish and Game, who were then chastised for this lobbying by the Governor. The ballot was voted into law by the Alaskan public. The new law states that no one who flies an aircraft to an area and lands, may shoot a Gray Wolf, fox, Lynx or Wolverine on the ground the same day. This closed the loophole left by the previous law.

Wolf hunting is carried out by snowmobilers in many parts of Alaska. Brenda Peterson, an eyewitness to one of these hunts, described it, and photos taken of the event documented the wolves being chased into a tight group and killed (McIntyre 1995). Six black wolves, an entire family, died "splayfooted against one another," having run for their lives at a gallop of 35 miles per hour as the snowmobilers herded them into a terrified, dense mass, and then shot them at point-blank range (McIntyre 1995).

The total kill of wolves by hunters and trappers in Alaska in recent years has declined from 1,600 taken in the winter 1993 to 1994 to 1,180 taken in 1995 to 1996, according to the Alaska Department of Fish and Game. With a total wolf population in the state in late 1995 estimated at about 7,000, the kill represents 17 percent of the total population. This is probably threatening some populations. One race of Alaskan wolves, the Alexander Archipelago Wolf (*Canis lupus ligoni*), an extremely rare subspecies, resides in the heavily logged Tongass National Forest. In spite of various threats, the US Department of the Interior has refused to list the wolf on the US Endangered Species Act (see Forests chapter).

Within the past few decades, wolves have again become resident in several western states. Beginning in the 1970s, a few Gray Wolves crossed the border from Canada into Montana's Glacier National Park where a population of about 100 wolves in 10 packs now lives (Stevens 1997).

In the 1990s, the Fish and Wildlife Service began a reintroduction program of wolves into Yellowstone National Park and portions of Idaho and Montana to the north. Historically, wolves were killed to the last individual in Yellowstone National Park by park service personnel under predator-control laws. Their return is a vindication of their importance in the ecosystem. From the start, the project was fraught with difficulties and controversy, with conservationists pitted against one another as to methods and regulations, and many cattle and sheep ranchers opposing the entire project, vowing to kill any wolves that strayed out of the park. Defenders of Wildlife began a fund to repay ranchers for lost livestock, which helped convince some ranchers to accept the project. Of the 14 Canadian wolves released in 1995 in Yellowstone National Park, almost all remained within the park. Two packs produced a total of nine pups, and 17 more wolves from Canada were set free in the park in 1996. The largest of the reintroduced wolves and his mate left the park, and he was gunned down by a drunken man for sport; he skinned this big male and threw the carcass into the brush. Later, the wolf's pregnant mate found the skinless carcass and dug a den beside it. The hunter who, in defiance, sported a shirt reading "Northern Rockies Wolf Reduction Project," spent six months in jail and a year of supervised probation after being found guilty of deliberately killing the wolf.

These Canadian wolves, taken from areas where they were hunted and trapped, experienced a trap- and gun-free environment in Yellowstone National Park. They have adapted well, preying mainly on Elk, which had become overpopulated. Only a few Bison have been taken. Within a few years, the wolves have had major effects on the park's ecosystem. Grizzly Bears have benefited by feeding off the remains of wolf kills, as have ravens, foxes, Bald Eagles and Golden Eagles. The park's aspen trees have also benefited. Researchers from Oregon State University determined

that until the late 1920s, young aspens were able to survive and mature within existing groves, but after the last wolves were killed off about 1926, the aspens began to die out because the overpopulated Elk browsed on these trees in the winter, stunting them. Another change that resulted from the absence of wolves was the disappearance of smaller birds, such as the Calliope Hummingbird (*Stellula calliope*) and Willow Flycatcher (*Empidonax traillii*), from brushy areas that were heavily browsed by the large populations of Elk and other ungulates. Wildlife Conservation Society (WCS) biologists have been researching the many effects of the return of wolves on the park's ecology (WCS 2000).

By 1996, three packs of wolves occupied the park, and a fourth pack of four wolves lived on the park's northwestern border. Their total population in Yellowstone has risen to about 185, exceeding the expectations of scientists (Murphy 2000). Although detractors remain, wolves have garnered a great deal of support. Scientists have come to Yellowstone National Park to study the wolves, some saying it is the best place in the world to see these animals in an open habitat, exhibiting natural behavior. Tourists, likewise, have flocked to see the Yellowstone wolves, bringing $43 million a year to the area, according to Defenders of Wildlife (Rembert and Motavalli 1998). Visitors have been thrilled to see these wolves streak across the grasslands, meet in affectionate, playful groups and raise their melodious voices in group howls. The wolves are expected to be a major tourist attraction in the future, perhaps rivaling the world-renowned geysers. Television films have been made of the wolves, chronicling their reintroduction and pack behavior, and *The Return of the Wolf to Yellowstone*, a book by Thomas McNamee (1997), recounts their reintroduction.

The wolves were released under a special designation of the US Endangered Species Act known as "non-essential, experimental populations," a category that permits authorities to kill them if they are found preying on livestock, or even if they cause adverse effects on wild ungulates such as deer and Elk. It is not legal to kill them for sport deliberately (FWS 1994). As a result, many wolves straying outside Yellowstone National Park have not fared well. One pack of 13 that roamed the plateaus north of the park declined to a single wolf in one year; all but three, who are now back in captivity, died or were shot (Murphy 2000). Several conservation organizations sued the Fish and Wildlife Service to appeal the non-essential designation, stating that there were already some wolves present that would be killed at will because of the designation. Livestock owners also sued the government, requesting that the program be stopped and the wolves be removed. These lawsuits were not heard in federal court until late 1997, after 66 wolves had been brought from Canada to Yellowstone and Idaho in 1995 and 1996.

In December 1997, the lawsuits from both sides of the wolf issue were finally heard in a US District Court, which came to the stunning decision that the Fish and Wildlife Service had violated the US Endangered Species Act by declaring the wolves an experimental population because wolves that might already be present would be denied full protection of the law. The judge ordered that the reintroduced wolves be removed from the park, but stayed his own decision pending appeal. Secretary of the Interior Bruce Babbitt expressed the Department's support for keeping the wolves in the wild. The Fish and Wildlife Service stated that should the decision be upheld on appeal, the wolves would have to be euthanized, as there was no area where they could be released (Chadwick 1998). The decision was appealed and overturned in January 2000, allowing the wolves to remain as part of Yellowstone's ecosystem for the indefinite future.

For the long-term success of the reintroduction of Gray Wolves into this region, the entire Yellowstone ecosystem, which extends well beyond the limits of the national park and other federal lands, should be protected. Already, much prime habitat that was once occupied by wildlife has been converted for agriculture, livestock and homes. Growth of housing and spread of the urban landscape in Jackson, Wyoming, are gobbling up thousands of acres each year. At least one cattle ranch has recently been purchased as a buffer for wolves and bison straying out of Yellowstone National Park. Efforts should be made to acquire more habitat so Yellowstone's wolves and those to the north could be linked through forest corridors to avoid inbreeding and provide space for expanding populations. The Greater Yellowstone Coalition has proposed a program called Y to Y, or Yellowstone to Yukon, that seeks an even more ambitious goal: to link reserves and parks between the two areas, providing a vast wildlife corridor. Much of the land in this linkage area is already federally owned. Grizzly Bears and wolves are among the many wildlife species that

require enormous amounts of habitat, and unless action is taken now, populations of these and other wide-ranging animals will become isolated and inbred.

Central Idaho has 12 million acres of national forest land and was chosen as a release site because of the enormous potential habitat. Opposition to the reintroduction in Idaho was strong, and the state legislature blocked the involvement of the state wildlife department (Robbins 1997). The Nez Perce tribe, which has a strong commitment to preserving the wolf, stepped into the void and became the first Indian tribe to manage an endangered species in an entire state (Robbins 1997). The project is headed by a tribal leader, Jaime Pinkham, a forest biologist who returned to his tribal roots and became manager of the Nez Perce Department of Natural Resources (Robbins 1997). Conservation groups, such as the Gray Wolf Education and Research Center in Idaho, are attempting to change the anti-wolf opinions of local ranchers with films, several penned wolves and other programs. Unfortunately, wolves have been released in Idaho and in Montana, where many have been shot, trapped or died from other causes. They lack the protection of a large national park where hunting and trapping are prohibited, and many ranchers graze cows and sheep in and near the national forests.

Most wolves prefer wild prey, but because of the large number of livestock in the region, the success of these releases may depend on whether the wolves can be conditioned to keep away from livestock. Several of the reintroduced wolves have killed calves in Idaho and Montana, resulting in anger from ranchers who have convinced the Governors and many state delegates to legislate against the program. Fears have even become irrational. Some ranch mothers sent letters to Idaho's Congressional delegation demanding that children be guarded from wolf attacks at school bus stops (Corbett 2000). The Republican delegation from Idaho passed a unanimous resolution at their convention, calling for the immediate removal of all reintroduced wolves (Corbett 2000). Signs urging that wolves be killed were placed in store windows in Idaho. Fish and Wildlife Service biologists killed 82 wolves during the first five years of the program, after complaints from livestock owners (Corbett 2000). Several wolves were shot under questionable circumstances. After a calf was killed, for example, the Service ordered three adult males of the pack killed from a helicopter; sharpshooters, unable to kill the adults, ended up shooting three pups (Murphy 2000). After ranchers reported that a pack had backed a group of his horses against a cliff, the alpha male was removed, leaving his mate alone and the pack without a leader (Murphy 2000).

Some environmentalists protested these killings and threatened to interfere before more wolves were shot (Corbett 2000). David Gaillard of the Predator Conservation Alliance questioned the wisdom or purpose of introducing wolves that needed to be controlled and trained (Murphy 2000). Experiments are underway using electric shock collars that shock a wolf when it comes close to a cow or calf wearing a collar that sets it off. This is a crude approach, which inflicts pain on the wolves and may not even succeed in its intent. Some humane organizations that have protested these collars have rightly stated that almost no efforts have been made to teach ranchers to protect their livestock with sheepherding dogs, pen them in at night and before calving and lambing, and use other means of preventing predation.

Wolves, Wild Dogs and Foxes: Page 7

Historically, the critically endangered Mexican Gray Wolves (*Canis lupus baileyi*) roamed montane woodlands and drylands in northwestern Mexico and extreme southern Arizona, New Mexico and Texas. After centuries of persecution, they disappeared altogether from the United States and verged on extinction in Mexico. In 1976, the subspecies was listed on the US Endangered Species Act, and in 1982, the Fish and Wildlife Service approved a recovery plan in which a professional trapper was hired to capture the last few wild wolves in Mexico. Only five of these wolves were found, and in this 11th-hour rescue, they were live-trapped in Chihuahua and Durango for captive breeding (Brown 1995). They have bred well in captivity and, in 1998, numbered 175 distributed in a number of American zoos (Bass 1998). Through genetic testing, new strains of pure Mexican Wolves have been identified in

Mexican Wolves already in captivity; this adds to the subspecies™ known diversity (Brown 1995). Smaller than northern wolves, males weigh 60 to 70 pounds and females 50 to 60 pounds.

The recovery plan's major goal was to reintroduce Mexican Gray Wolves into portions of their original range in a joint project by the Fish and Wildlife Service, the ADC program which had been responsible for their demise, the US Army, and the state wildlife departments of Arizona and New Mexico (Brown 1995). Surveys conducted in the region determined that most people favored the reintroductions (Brown 1995). Ted Turner, the founder of Cable News Network (CNN) and other cable stations, is New Mexico's largest landowner with more than 1 million acres. He offered one of his ranches, Ladder Ranch, which is near the Blue Range mountains release site, as a holding area and paid an employee to oversee construction of holding pens (Bass 1998). This was supported by his organization, the Turner Endangered Species Fund (Bass 1998).

Although the public as a whole supported the wolf reintroduction, many New Mexican ranchers expressed great antipathy. The national forest release sites allow hunting and trapping. Many volunteers and a grassroots organization, Preserve Arizona's Wolves (PAWS), have worked for decades to bring about this reintroduction and volunteered their time to help on Ted Turner's ranch preparing for the arrival of wolves from two zoos (Bass 1998). In December 1997, four wolves, two sisters and two brothers from separate zoos, arrived at Turner's ranch and were paired off male-and-female in separate pens, where they stayed for several months (Bass 1998). More arrived and spent time in acclimatization pens before release. The release program failed. Of 11 Mexican wolves released in the area, five died, one disappeared and is presumed dead, and five have been returned to captivity near Alpine, Arizona (Sink 1998). One pup born in the wild is missing and presumed dead, since its mother was shot in August 1998 (Sink 1998). A New Mexican rancher is said to have offered $35,000 to anyone who would kill all the wolves returned to the wild (Sink 1998).

Among the wolves that were shot was one of a newly formed--but strongly bonded--pair, Val and Minnie (Bodo 1999). Soon after release from the holding cage, Val was shot by a camper who claimed that the wolf charged at him; a necropsy revealed that the wolf had been killed standing still, broadside to the man (Bodo 1999). The female, Minnie, who had been born at the Rio Grande Zoo in Albuquerque, was pregnant with four pups when her mate was killed. She was returned to her holding pen and began to try frantically to dig and leap her way out of the pen (Bodo 1999). Her pups were born, but all died. At the end of 1998, she was shipped to the Living Desert Wildlife and Botanical Park in Palm Desert, California, where she paced or remained curled up in a spot of dirt, failing to interact with her surroundings or a male put in her pen (Bodo 1999). She was spayed and will remain in captivity for the rest of her life. As for the other deaths, no examples of livestock predation were found. About 140 of these wolves remain in captivity (Nowak 1999).

The reintroduction of Mexican Gray Wolves will be far more difficult than the Yellowstone National Park reintroduction, which involved transplant of wild Canadian wolves. These captive-born wolves have no knowledge of wild survival. They will need to learn how to hunt large prey as a pack, as well as how to survive the many threats humans pose to them. Their intelligence and instincts may be the deciding factors for their survival.

The legal status of the Gray Wolf in the lower 48 states seems destined to change in the near future. The Fish and Wildlife Service wants to change the status of the species from Endangered to Threatened in all but the southwest, where the Mexican subspecies is being reintroduced, and remove the Minnesota wolves altogether from the US Endangered Species Act (Revkin 2000). Minnesota wolves continue to be persecuted, and suffer from parasitic heartworms and deadly canine parovirus disease spread by domestic dogs (Nowak 1999). Delisting undoubtedly will unleash unrestricted hunting and trapping of these animals. Total legal control will revert to the state of Minnesota should this proposal be finalized.

The wolves in the West, from Yellowstone National Park to Idaho, Montana and Washington, would be listed as Threatened when removed from the experimental category. This category has much more flexibility concerning how much protection a species receives. Penalties are lower, and species may be hunted and trapped under the category.

Some ranchers in the West are prepared to eliminate wolves outside national parks. One rancher in Montana installed loud alarms that are triggered by the radio collars used to monitor most of the area's wolf packs (Revkin 2000).

The approximately 3,500 wolves south of Alaska, most of which are in Minnesota, occupy only about 5 percent of their original range, and as a result of prejudice and unfounded fear, these wolves are still being persecuted. Several states have enacted laws banning reintroduction of wolves, which would also apply to wolves crossing over the state's borders. Proposals to reintroduce wolves into Maine or New York have also been met with opposition by many (Higgins 2000). A major education program is needed to allay these fears and to train ranchers to protect their herds and flocks, compensating them for any losses. Although the detractors speak more loudly than the defenders of wolves, the latter probably far outnumber the former in the United States as a whole. It may fall to private conservation and humane organizations to turn the tide in favor of the wolves to return them to a greater percentage of their original range in the lower 48 states.

Wolves, Wild Dogs and Foxes: Page 8

Elsewhere, the history of the Gray Wolf is similar. As early as 300 B.C., Celtic people in the British Isles began breeding wolfhounds for chasing and killing wolves (McIntyre 1995). The King of Scots decreed in the second century B.C. that anyone killing a wolf would be rewarded with an ox (McIntyre 1995). In Anglo-Saxon England, January was designated Wolf Month, to be devoted to the slaughter of wolves; during the reign of King Edgar of England, beginning in 953, a tribute of 300 wolf skins per year was demanded. In 1281, King Edward I hired a man to devote himself entirely to killing wolves (McIntyre 1995). Over the next centuries, wolf extermination campaigns continued in the British Isles, and forests were leveled for livestock grazing and agriculture. The last wolf in Ireland was killed in 1821, and a wolf killed in Scotland in 1848 resulted in the extinction of the species throughout the British Isles (McIntyre 1995).

In France, Emperor Charlemagne founded an order of knights for killing wolves, called the Louveterie, about A.D. 800 (McIntyre 1995). Wolves were exterminated 1,000 years ago in all but remote forests of the French Pyrenees on the border with Spain. By the 20th century, only a handful of Gray Wolves survived in these forests, and apparently they were killed off in the 1950s. In the early 1990s, small numbers of Gray Wolves crossed over the Alps from Italy into southeastern France. In 1999, the French government decided to remove these 40 wolves, killing or caging them, after complaints by herdsmen that the wolves were killing sheep (Newman 1999). Environmentalists claimed the sheep were being killed by feral dogs (Newman 1999).

The last wolf in what is now Germany was killed in 1847 (McIntyre 1995). Within the past decade, a few wolves have entered eastern Germany from Poland, which has a population of about 1,000 wolves (McNamee 1997). Polish wolves have been heavily persecuted for centuries, and only in 1998 did the species receive official protection (Nowak and Myslajek 1999). They occur mainly in eastern mountains where they have come into conflict with livestock owners. An organization, Wolfnet, has been working with livestock owners to compensate them for losses and protect them against predation by wolves (Nowak and Myslajek 1999). Wolfnet travels around the country educating the public, government officials and students about the behavior, biology and intelligence of wolves, attempting to undo the mistaken beliefs that result in many killings of wolves (Nowak and Myslajek 1999).

Scandinavia has nearly wiped out its wolves, with only about 25 in Norway and Sweden and fewer than 100 in Finland (McNamee 1997). In 2001, the Norwegian government allowed the killing of some of the few remaining wolves because of complaints by livestock owners, despite protests from wildlife organizations in the country. An unknown--but small--number also survive in Greenland (McNamee 1997).

In Spain, wolves may total from 1,500 to 2,000, the largest population in Western Europe (McNamee 1997, Binder

2000). They are heavily persecuted there, however. At one time wolves were found throughout the Iberian peninsula, but they are now confined to the northern portions of Spain and Portugal (Bergman 1997). In Portugal, only about 150 survive. The wolves of Spain and Portugal are listed by the *2000 IUCN Red List of Threatened Species* as Conservation Dependent. At least half of rural people in areas where wolves remain in Iberia believe the animals should be exterminated altogether, while another 35 percent want them "controlled," allowing only a few to survive (Bergman 1997). Wolves may be sport hunted in Spain, resulting in the deaths of at least 300 animals a year; added to this mortality, the practice of denning, or killing pups in a den, is legal, and 25 percent of wolves are killed in this manner (Bergman 1997). Luis Mariano Barrientos, a biologist studying Spain's wolves, has documented that they kill relatively few sheep, which are usually protected by mastiff dogs and shepherds. He says that the wolves are killed because of prejudice and persecution, and laments, "It's a national disgrace. A barbarity" (Bergman 1997). A recent study recommended that a strict compensation program be set up. At present, indemnities are paid only if local administrations choose to do so, and many do not (Bergman 1997). This results in great resentment toward wolves. The wolves of Spain survive by stealth, hiding in fallow fields and moving about at night, and when they howl, they risk their lives (Bergman 1997). For long-term survival in Spain, they need a large sanctuary with natural prey species.

Small populations of Gray Wolves still remain in pockets of the Mediterranean region. About 500 wolves survive in Italy, listed as Vulnerable by the International Union for the Conservation of Nature (IUCN). Very little wilderness remains in the country, and wolves have been squeezed into agricultural and livestock grazing areas (McNamee 1997). Their survival until the 20th century is due to an attitude of tolerance, unlike the prejudice and hatred toward wolves so common in Europe. No national extermination campaign was ever launched, and herders corral their sheep at night and protect their flocks with guard dogs (McNamee 1997). Because of a lack of natural prey, such as deer, in the region, these wolves occasionally kill livestock. When this happens, herders put out poison or shoot the wolves. Italian wolves live in pairs or groups of three in most areas because there are no large ungulates to hunt in packs. This has made them quiet, nocturnal and shy. These wolves also prey on small mammals, such as rabbits and marmots (McNamee 1997). Only in a few national parks, such as the Abruzzi east of Rome where about 20 to 30 wolves hunt deer, do they exhibit natural behavior, forming packs and howling (McNamee 1997). Even there, however, sheep are allowed to graze within park boundaries, and sheep owners have been soliciting members of the public to "adopt" a sheep to contribute to the cooperative farm (Stanley 2000). By the 1970s, wolves numbered only a few hundred, but after the government accorded the species full protection in 1976, they began to increase in numbers and range (McNamee 1997). They now occupy the entire country, and if there are livestock losses, owners are compensated and are not allowed to kill the wolves (McNamee 1997). Professor Luigi Boitani, a wolf biologist at the University of Rome, commented at a wolf conference that most of the Italian public is in favor of wolves and more opposed to control programs than some wildlife managers, like himself (Binder 2000). The official protection given to these wolves is far stronger than that given to either the Gray or Red Wolf in the United States.

Southeastern Europe's wolf populations are fragmented, but increasing in some countries. The former Yugoslavia has about 930; Hungary, 50; Romania, which protects the species, 2,500; Bulgaria, fewer than 100; Slovakia, 350; and Greece, 300 to 500 (McNamee 1997). Romania is the only one of these countries where people have a tradition of honoring wolves; sheep in the country are protected by guard dogs, and wolves prey mainly on native ungulates. In some areas the wolves have taken to ranging through city trash piles for food (Binder 2000). Croatia allowed unlimited killing of wolves until 1995 when fines of up to $6,000 were imposed for killing wolves (Binder 2000). This had the counter-effect of encouraging wolf killing, resulting in the deaths of more than 40 wolves, and no one has paid a fine; about 100 wolves remain in the country (Binder 2000).

In the eastern Mediterranean, there are estimates of a few wolves remaining in Lebanon; about 30 in Egypt; 200 in Jordan; 150 to 300 in Israel; several thousand in Turkey; and about 1,000 in Iran (McNamee 1997). In Saudi Arabia, where wolves are killed to protect livestock, hunters often string up a wolf carcass on a pole for all to see (Binder 2000). Dr. Iyad A. Nader of the King Khalid Wildfire Research Center in Riyadh, estimated that up to 700 wolves remain in three protected areas of Saudi Arabia, but elsewhere in the country they have no legal protection (Binder 2000). Wolves are persecuted by livestock herders in all the latter countries.

Just after World War II, there were between 150,000 and 200,000 wolves in the Soviet Union, but beginning in 1947, an intensive government control program drastically reduced their numbers (Nowak 1999). The annual kill was 40,000 to 50,000 until 1962, when it dropped to 15,000; in the 1970s, some 50,000 wolves were estimated to survive in the entire country, including the Central Asian Republics (Nowak 1999). After an increase in wolf populations, a sizeable bounty was paid for killing them; and in 1980, 35,573 pelts were taken through aerial hunting, poisoning and other means (Nowak 1999). fiThe Russian Grey Wolffl (1993, Anderson Video, California) chronicled this bounty hunting and other persecution. In the past 70 years, more than 1.5 million animals have been killed; about 20,000 wolf pelts are marketed in Russia every year (Busch 1995). In the early 1990s, 17,000 men were employed by the Russian government to kill wolves. Since then, the national bounty has been rescinded, and only some state governments pay the equivalent of $25 for a female; the central government no longer encourages poisoning wolves (Binder 2000). In the Russian Far East, a bounty program to kill wolves has been in place for decades, but with the economic chaos following the fall of the Soviet Union, funds to pay the bounties dried up (Specter 1997). A 2001 Cable News Network (CNN) report profiled a government trapper who killed female wolves for the bounty, then raised the orphan cubs for release. The report suggested that persecution continued at high levels and that most Russians wanted the species exterminated.

The Wolf Almanac (Busch 1995) states that some 96 Russian wildlife reserves harbor wolves, and they are hunted actively in 41 of these. They are reported to be safest in certain large reserves, such as the Caucasian, Altai and Pechyora-Ilych reserves, unless they stray outside to prey on livestock (Busch 1995). Wrangel Island in the Arctic Ocean is to be made into a nature preserve with a wolf colony to cull the large herds of Musk Oxen and Caribou (Binder 2000).

Japan's wolves were killed off 100 years ago, and public opinion is negative about their reintroduction. Biologists want them reintroduced to control Japan's overpopulated Sika Deer, which are damaging forests (Binder 2000).

In Kazakhstan and Central Asia, wolves and Saiga antelope have coexisted for eons, but during this century, both have come under heavy hunting. A film, fiThe Saiga of Kazakhstanfl (see Video Section), describes the detrimental effect that wolf control programs have had on Saiga. Wolves are estimated to number between 90,000 and 100,000 in the country, but biologists claim that they kill large numbers of domestic camels, cows and sheep (Binder 2000). Killing wolves is considered a sport in Kyrgyzstan, south of Kazakhstan, where Golden Eagles are used as falconry birds to hunt foxes, badgers, Lynx and wolves (Kinzer 1999).

Mongolia has an estimated 10,000 wolves; China only about 400; and Afghanistan, 1,000 (McNamee 1997). In Tibet, wolves are heavily persecuted by livestock owners, and in the vast Chang Tang Reserve, it is the only species without legal protection. Wolf carcasses can be seen lying next to roads, the animals having been shot by hunters in vehicles, and biologist George Schaller (1998) saw three wolf bodies in a village dump with their jaws wired shut.

India has fewer than 1,000 wolves by some estimates (McNamee 1997), and between 800 and 2,000 in the opinion of Dr. Yadvendradev Jhala of the Wildlife Institute of India. The species is held in great fear by many Indian people, who regard wolves as man-eaters. A century ago, a bounty program resulted in the slaying of 2,600 wolves (Burns 1996). Indian Gray Wolves (*Canis lupus pallipes*) were finally accorded official protection in India in 1992. Rudyard Kipling's *The Jungle Book* tells the story of Mowgli, an Indian orphan raised by wolves. This story may have a basis in fact because many unwanted children are abandoned and placed in the woods, according to *The Wolf Almanac*, and Indian folklore recounts many cases of small children raised by wild wolves (Busch 1995). Such a child was discovered in 1972 at the age of four, apparently having been adopted by a pack of wolves. He was placed in Mother Theresa's refuge for orphans in Lucknow, where he died after seven years (Busch 1995). In spite of such true stories, the average Indian has little but fear and loathing for wolves.

Working to help India's wolves, Dr. Jhala and the Wildlife Institute of India are conducting surveys and appraising their status. For centuries, these wolves have lost habitat and prey species to the country's growing human population. When wolves turned to livestock, persecution followed. Dr. Jhala admits, "It is extremely difficult to conserve a

species when the majority of the human population is opposed to its survival" (*Earthwatch* 1996). Beginning in 1988, Dr. Jhala conducted the first-ever ecological study of Indian wolves for his doctorate at Virginia Polytechnic Institute, with funding from the National Geographic Society and the Smithsonian Institution (*Earthwatch*, 1996). Earthwatch contributed to this research in 1996 with its volunteer program of paying participants in Dr. Jhala's studies. These volunteers followed radio-tracked wolves in the 3,400-hectare (8,401-acre) Velavadar National Park of western India, one of the wolf's last strongholds, observed Blackbuck (*Antilope cervicapra*), Nilgai (*Boselaphus tragocamelus*) and other rare wildlife, and interviewed local farmers through interpreters about their opinions of this species.

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Official protection from hunting and trapping has been accorded very few wolf populations in the world, even where they are on the verge of extinction. In some areas, however, attitudes are changing, most dramatically in the United States, where documentary films and books on their behavior and importance in ecosystems, as well as recordings of their howls can now be seen in bookstores throughout the country. Superb photography illustrates some of these, most notably *White Wolf: Living with an Arctic Legend* (Brandenburg 1992), which provides glimpses into the lives of these fascinating canids in the Canadian north. Reintroductions of wolves into portions of their former range in the American West bode well for their future, unless the prejudices of many livestock ranchers hold sway. Canada may have the largest population of wolves in the world, estimated at between 30,000 and 60,000, with about 4,000 killed for fur each year (Nowak 1999). According to genetic studies, the wolves of southern Ontario and southern Quebec have apparently hybridized with Coyotes, as have wolves in neighboring Minnesota and Isle Royale, Michigan (Nowak 1999).

The ecotourism potential for wolf viewing in many parts of the world is considerable. In Ontario, Canada, visitors to Algonquin Provincial Park have come to hear packs howl since the 1960s. One of the first wolf conservationists, Canadian wolf biologist Dr. Douglas Pimlott, initiated these tours and educated thousands of people about the biology, importance to ecosystems and behavior of wolves. Their value in attracting tourists and contributing to healthy ecosystems far exceeds that of their pelts.

For some other species of wild dogs, attitude changes may not be enough to save them. The Dhole or Asiatic Wild Dog (*Cuon alpinus*), a small canid the size of a Coyote, is native to Asia, from southern Siberia and Central Asia east to India and Indonesia (Nowak 1999). This wild dog has rusty red fur on its upper parts, and white on its chest and belly. Hunting in large packs, Dholes pursue large prey, such as deer, wild pigs, antelope and wild sheep (Nowak 1999). Their social structure is not well known but appears similar to the Gray Wolf's, with a leader and lower-ranking members of the pack (Nowak 1999). Although Dholes seldom take livestock, they have been poisoned intensively and hunted throughout their range; they are also persecuted by hunters who regard them as competitors for game species (Nowak 1999). Dholes have disappeared from much of their habitat, and the *2000 IUCN Red List of Threatened Species* lists the species as Vulnerable, the category below Endangered, indicating a serious decline.

Similar in appearance, the Simien or Ethiopian Wolf (*Canis simensis*) is endemic to Ethiopia. Scientists were unsure in the past whether this animal was a dog, a wolf, a jackal or a fox. Most zoologists now describe it as a wolf. It may be related to the small race of Gray Wolf, *Canis lupus arabs*, that inhabits the Arabian Peninsula across the Red Sea (Nowak 1999). Simien Wolves have a head and body length of about 3 feet, are about 2 feet tall at the shoulder, and weigh from 11 to 19 kilograms (Nowak 1999).

The only wolf not preying on animals larger than itself, such as deer, but living in packs, Ethiopian Wolves feed mainly on small rodents (Gottelli and Sillero-Zubiri 1994). Once their range was far greater, encompassing most of Ethiopia's highlands, but with the development of agriculture and spread of livestock grazing, these wolves lost the majority of their habitat and came under totally unmerited persecution as a threat to domestic animals (Nowak 1999).

Today, they have become restricted to only about six locations in the Ethiopian highlands. Discovered in the Simien Mountains of the northwest, the subspecies, *Canis simensis simensis*, was estimated at only about 40 animals in the 1980s. These wolves are so shy that even in the Simien Mountains National Park they have become nocturnal and stay in burrows when humans are in the vicinity. A crew from Survival Anglia, a British nature film company, spent weeks in the early 1990s seeking to photograph the Simien Wolves in this park, finally having to settle for a long-distance view of a solitary wolf.

Wolves of the Bale Mountains, separated by hundreds of miles, are larger and redder than the Simien Mountains race, and this subspecies, *Canis simensis citernii*, is somewhat more numerous than the other race. Only about 440 Simien Wolves were thought to survive in the Bale Mountains in the early 1990s, with perhaps another 100 in the Simien Mountains (Gottelli and Sillero-Zubiri 1994). Today, estimates are even lower. The Bale Mountains population is estimated at 270 to 370 animals, and 70 to 150 survive in the Simien Mountains (Nowak 1999). This species is thus at the edge of extinction. It is listed as Critical in the *2000 IUCN Red List of Threatened Species*, protected by law in Ethiopia and listed as Endangered on the US Endangered Species Act.

The Wildlife Conservation Society (formerly the New York Zoological Society) has funded research projects on the Simien Wolf for many years, including the studies of two zoologists, Dada Gottelli and Claudio Sillero-Zubiri in Bale National Park. Simien Wolves use their long legs to dig into rodent tunnels, aided by their acute senses of hearing and smell. In Bale Mountains National Park, 14 rodent species are native and three dominant species are endemic to the region, providing a huge food base for the wolves. They specialize in preying on the endemic Ethiopian Mole Rat (*Tachyoryctes macrocephalus*). The mazes of tunnels that these rats excavate aerate the soil, creating rich topsoil which nourishes the lush grasses in this highland ecosystem. The wolves have been seen hunting cooperatively, chasing young antelope and hares (Nowak 1999).

Livestock grazing is allowed in Bale Mountains National Park, and Simien Wolves wander among the cattle, presenting no threat. The wolves in this park have not been persecuted, unlike those elsewhere in Ethiopia, and do not hide from people. Filmmakers shooting the 1990 BBC film, fiKing Solomon's Mountains,fl found the wolves in the open during the day, with adults hunting rodents, and pups playing wrestling games. Like other wolves, they are extremely affectionate with one another and yip in group choruses, sounding like Coyotes. Packs range in size from five to 13 animals, and they defend territories. As in Gray Wolf packs, only one female in the pack breeds, and because of limited habitat, nonbreeding females often stay with the pack, acting as "aunts" instead of leaving to begin their own packs (Gottelli and Sillero-Zubiri 1994).

Domestic dogs, brought into Bale Mountains National Park by the Oromo people to protect their flocks of sheep and cattle from hyenas, are a major threat to this species (Gottelli and Sillero-Zubiri 1994). Wolves have succumbed to diseases introduced by these dogs, which are not fed but set free to fend for themselves. Between 1992 and 1995, the Bale Mountains wolves were decimated by an outbreak of canine distemper acquired from these dogs, reducing the wolves from 240 to 140 (Anon. 1996). In the mid-1990s, more died of rabies. An even more ominous threat is their interbreeding with domestic dogs. The film fiKing Solomon's Mountainsfl showed a pack of wild Simien Wolves led by a large black dog that had become the lead female. Another film, fiLast Wolves of Ethiopia,fl shown on a National Geographic Explorer program in early 1998, recounted the story of a young female Simien Wolf who was ousted from her pack and, after a few years of wandering, paired with a hybrid wolf-dog. In general, male domestic dogs have bred with female wolves, diluting the genetic integrity of this highly endangered animal (Gottelli and Sillero-Zubiri 1994). Some populations of pure Simien Wolves are showing signs of inbreeding, due to their small genetic base. The combination of these threats has led scientists to predict imminent extinction for this beautiful wild dog.

To prevent their extinction, attempts are being made to convince the Oromo tribespeople to control their dogs, but scientists have concluded that captive-breeding may be the only way to save the species (Gottelli and Sillero-Zubiri 1994). There is no possibility of preventing these people from entering the park because of the tribe's centuries-old ties with this region and the potential of bad relations with them that could have serious repercussions on the conservation of park wildlife (Gottelli and Sillero-Zubiri 1994). As a means of controlling the domestic dogs, they could be

neutered, vaccinated against disease, and provided supplemental food to prevent their attacking native ungulates in the park. A vaccination program has recently been carried out in the Serengeti, where domestic dogs transmitted canine distemper that killed one-third of the Lions in the region.

The South American Maned Wolf (*Chrysocyon brachyurus*) has also declined, although not as drastically as the Ethiopian Wolf. This long-legged wolf, weighing only about 44 pounds, hunts in the tall grasses of pampas and llanos, and eats rodents and other small mammals, birds, reptiles, insects, fruit and other vegetation (Nowak 1999). With shaggy red fur and black legs, it has been called a Red Fox on stilts. It is the sole member of its genus and the only wolf in Latin America. The Falkland Island Wolf (*Dusicyon australis*), native to the Falkland Islands off Argentina, became extinct in 1876 after large numbers were killed by fur traders and poisoned by sheep ranchers (Allen 1942). The size of a large Coyote, it may have evolved from foxes. Maned Wolves have been falsely accused of killing livestock, and persecution has caused them to disappear from Uruguay and most of Argentina. They have become rare in Brazil and the rest of their range in south-central South America. The Maned Wolf is listed on the US Endangered Species Act as Endangered and on the *2000 IUCN Red List of Threatened Species* as Near-threatened.

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Small predators also underwent persecution in North America in the late 19th and early 20th centuries. Two tiny western foxes that were once considered to be the same species, the Swift Fox (*Vulpes velox*), native to shortgrass prairie, and the Kit Fox (*Vulpes macrotis*) of intermountain and desert grasslands further west, both declined as a result of predator-control programs. Both are shades of tawny, reddish-brown and tan, stand about 1 foot tall, measure 23 to 31 inches long, and weigh less than 5 pounds (Nowak 1999). Although not considered threats to cows or sheep, foxes traditionally have been killed because of their possible threat to poultry. In wilderness areas, they have been killed merely because of predator prejudice. These foxes subsist on small rodents and even insects, such as grasshoppers, and are, therefore, beneficial.

The Swift Fox was named for its speed when streaking across the prairie, clocked at about 25 miles per hour (Turbak 1993). The Canadian populations of the Northern Swift Fox (*Vulpes velox hebes*), native to southern Saskatchewan, Alberta and Manitoba, and the northern edge of the shortgrass prairie that once stretched to Texas, are listed as Endangered on the US Endangered Species Act but are extinct. They disappeared from the wild by the 1930s, after control programs were implemented, and Canadian wildlife authorities have reintroduced Swift Foxes of a related subspecies from Colorado, Wyoming and South Dakota (Nowak 1999). Some reproduction has taken place.

Swift and Kit Foxes began to decline in the 19th century, and Ernest Thompson Seton commented on the vulnerability of this species: "Harmless to man and mankind's interests; and yet he is going fast with all the other innocent and lovely wild things. Yes, faster than most, for he is the least cunning of our foxes--so guileless that he readily takes the poisoned baits used nowadays for killing coyotes" (Seton 1899). In fact, almost none of these foxes was seen in the wild from the early 1920s to the late 1950s, a period of heavy predator-control and poison campaigns (Chambers 1978). Both species have lost the majority of their habitats to agriculture. In North Dakota, the state lists the Swift Fox as an endangered species, with no breeding populations. The last known occurrence of the Swift Fox in this state was in the mid-1980s (Turbak 1993). Further south, this species is known to survive in southwestern Kansas, Nebraska, Montana, Wyoming and South Dakota (Chambers 1978). Some areas of unplowed prairie provide refuge. This fox has been able to colonize on roadsides next to fields and in the few remaining unpoisoned prairie dog towns. Some research has been carried out on the wild behavior and habitat needs of Swift Foxes in the Midwest, and there is room for cautious optimism that increased attention to this little fox will result in strong legislation to preserve it and prevent persecution and poisoning. Author Glenn Chambers was researching an article for *Audubon* magazine, "Little Fox on the Prairie" when he saw a fox family being killed by two farmers who poured gasoline in the den entrance and set fire to it. The male fox, provider of food for the vixen and pups, was found in a ditch a few yards away, his rib

cage ripped out by a high-velocity bullet (Chambers 1978). The vixen had escaped the burning den with two of the pups, but the farmers shot her as she watched over them (Chambers 1978).

Kit Foxes occupy deserts, dry grasslands, and montane areas with scattered trees from Utah north to Washington state and west to California. They prey mainly on kangaroo rats and other small rodents. A subspecies from southern California known as the San Joaquin Kit Fox (*Vulpes macrotis mutica*) is listed on the US Endangered Species Act as Endangered. Settlement and farming of the region reduced their habitat, and predator control has eliminated entire populations, causing them to dwindle to a few thousand animals. This delicate, little buffy-yellow fox is now restricted to a tiny remnant of its once immense habitat of mixed grasslands, deserts and shrub in California. Their original range stretched from San Joaquin and Stanislaus counties in the north to Kern County in the south. They probably numbered at least 12,000 prior to settlement (Turbak 1993). Tame and trusting, they became targets for hunters; even schoolboys with rifles have been seen shooting them as sport (Turbak 1993). One hunter was seen shooting a pair's tiny cubs one after another as they played at the den entrance, then killing the mother when she emerged to protect them (Turbak 1993).

Foxes have been considered threats to livestock and domestic poultry by European settlers. The Cape Fox (*Vulpes chama*) of dry country in southern Africa was the object of control programs by European settlers under the misapprehension that it preyed on domestic poultry. This resulted in declines in the numbers and range of this small, silvery-gray fox (Nowak 1999). The Hoary Fox (*Lycalopex vetulus*) of south-central Brazil, an endemic species of savannah grasslands, is persecuted by local people for presumed predation on domestic fowl (Nowak 1999). Although very shy, it courageously defends itself and its young when threatened (Nowak 1999). Little is known of its status, listed as Data Deficient by the IUCN. Argentine Gray Foxes (*Dusicyon griseus*), native to Patagonian grasslands, have been poisoned by livestock owners who distribute strychnine bait. Their populations have declined in many areas as a result, and thousands of non-target mammals and birds have died from these poisons. Such poisoning is illegal in Argentina, and efforts are being made by biologists and conservationists to stop this senseless killing.

Eight species of foxes are listed as Data Deficient by the *2000 IUCN Red List of Threatened Species*, and two species as Conservation Dependent. This is an indication of the lack of research on these ecologically important species, which perform the important role of consuming large numbers of rodents. Red Foxes (*Vulpes vulpes*), native to North America, Eurasia and northern Africa, have been persecuted as well, hunted as sport in England and parts of the United States, and killed by many farmers and livestock owners. One Midwestern town even rounded up these foxes once a year and beat them to death with sticks. After a *Life* magazine article describing this cruel persecution and the resulting public outcry, it ended. Fox hunting in England may end in the near future as the Parliament has voted to stop this cruel activity.

Bears

The immense Grizzly or Brown Bear, which once roamed the prairies and woodlands of western North America, inspired awe and fear in explorers and settlers alike. For thousands of years, Native Americans revered this bear. The Cree called it a four-legged human, and other tribes considered it a brother or cousin. They felt a kinship based on its intelligence and respected its great strength. They could not easily hunt it with bows and arrows, and when wounded, it showed great courage defending itself, able to cause severe injuries or death with its 5-inch claws.

The Grizzly reigned as the fearsome and unchallenged king of all wildlife on the continent, numbering at least 100,000 prior to the arrival of Europeans (Nowak 1999). These extremely adaptable bears lived in every western North American habitat except deserts. Arriving from Asia by way of the Bering Strait 12,000 years ago when sea levels were lower, Grizzlies gradually colonized western regions, the biggest of an array of large carnivores that inhabited the continent at that time, including dire wolves, hyenas and sabre-toothed cats. They survived the frigid and

harsh climate of the Pleistocene Ice Age. They thrived in prairies, especially those with scattered woodlands. In the 1500s, their range extended from the Arctic tundra south through the shortgrass prairie to the pine forests of northern Mexico, and west to the Pacific Ocean. In fact, the original range of the Grizzly Bear may have been larger than previously thought, reaching east to the Atlantic in Canada. A Grizzly skull has been found in a midden of the late 18th century, and pelts of these bears reportedly were taken in Labrador as late as 1927 (Nowak 1999).

Grizzly Bears of North America and Brown Bears of Eurasia were previously considered separate species, but today they are classified as a single one, *Ursus arctos*. The bears that live along the southern Alaskan coast and offshore islands, such as the Kodiak, are the world's largest carnivores (Nowak 1999). Weighing up to 780 kilograms (1,716 pounds), Kodiak Grizzlies have a shoulder height up to 1,500 millimeters (58.5 inches, or almost 5 feet), and a body length ranging up to 2,800 millimeters (109.2 inches, or 9 feet) (Nowak 1999). Standing height can be almost 12 feet. Adult males are larger than adult females. North American Grizzlies are far larger than bears of the same species native to southern Europe, which average only 70 kilograms (154 pounds) (Nowak 1999). Grizzlies of the northern portion of the lower 48 states are only somewhat smaller than the Alaskan bears, while those native to Arizona, New Mexico and Mexico, all now extinct, were smaller still, weighing less than 1,000 pounds.

Reproducing at a very slow rate, Brown Bear females have an average of two cubs only once every two to four years, and the cubs stay with their mother for this entire period (Nowak 1999). On occasion, only one cub is born, and sometimes up to four. If the mother is killed at any time before the cubs leave to be on their own, the cubs will also die because they are unable to fend for themselves, destroying two generations. The training period of these bears is extremely long, an indication of their slow maturation and the complexity of learning about food sources and other keys to survival. Another reason for this long apprenticeship is the potential of attacks by male Grizzly Bears. Until a young bear is 3 years old or older, it is not large enough to withstand an attack by an adult male, requiring the protection of its mother. Males continue to grow until they are 10 to 11 years old, and may provoke fights with younger bears to chase them from the territory, which prevents inbreeding. Females remain fertile until well into their 20s. Females in the Yellowstone region are known to live to be 25 years old, and Grizzly Bears may have the potential to live 50 years in captivity (Nowak 1999). They do not reach sexual maturity until they are at least 4 to 6 years old. These bears have a low natural death rate, and when combined with their slow reproduction, they are very vulnerable to extinction should they suffer high mortality.

A large habitat requirement is another aspect of their vulnerability. In the Arctic, a single Grizzly requires more than 100 square miles of tundra, and in the Yellowstone area, each bear occupies about 88 square kilometers (Nowak 1999). In regions where they are distributed sparsely, they can be eliminated easily, and even where they are more numerous, persecution and trophy hunting have caused local extinctions.

The strength, intelligence and size of the Grizzly, which have served it so well for thousands of years, were no match for European guns. Explorers, trappers and, later, settlers, slaughtered thousands of Grizzlies, killing them on sight. The first to disappear were the bears of the Great Plains, where the landscape was open and provided little cover. In some cases, these bears showed almost mythic strength upon being shot. Meriwether Lewis of the Lewis and Clark expedition of 1804 reported that one wounded bear ran at a fast clip for nearly a quarter of a mile before it fell dead after being shot through the heart (Peck 1990). Persecution of bears often includes the killing of their cubs. Early in the 20th century, President Theodore Roosevelt refused to kill bear cubs pointed out by his hunting guide, and when this was publicized in newspapers, he became a folk hero as a result. Toy manufacturers took advantage of the story by producing stuffed animal "Teddy Bears," which remain popular today. President Theodore Roosevelt left a legacy of destructive trophy hunting, however, including the killing of many adult bears.

Settlers moving into the West hunted these bears, and during the late 19th and early 20th centuries, government predator-control agents began campaigns to eliminate these bears. Much of the zeal with which the bears were slaughtered was based on a misconception: they were thought to be vicious man-eaters. In fact, they are mainly vegetarian and only occasionally kill animals for meat. The most common animals killed by Grizzly Bears are various types of rodents, such as ground squirrels and, in some areas, fish. Elk calves are killed as part of their diet in some

areas. The staple foods of the Grizzly diet are green shoots, sedges, clover and lilies early in the spring and, later in the summer, berries, roots, fruit, acorns and nuts, with occasional rodents (Peacock 1996). These bears do not consider humans to be natural prey, and attacks are rare. Prejudices dominated, however, and hunters who killed them were considered heroes and rewarded with bounty money. To protect their livestock, ranchers insisted that government hunters kill off every Grizzly Bear, and after several centuries of uncontrolled hunting, trapping and poisoning, the bears became extinct in their vast original realm south of Canada except for a few hundred animals protected in Yellowstone and Glacier National Parks.

All 26 subspecies of Grizzly Bears south of Canada and Alaska, except *Ursus arctos horribilis*, became extinct by the 1950s, and some disappeared during the 19th century. The latter subspecies, named from specimens obtained in northeastern Montana, barely survived. In fact, *Ursus horribilis* was the species' scientific name until recently, an indication of the prejudice against it. Now considered a subspecies, *Ursus arctos horribilis* is listed on the US Endangered Species Act as Threatened, and this subspecies is used to indicate all Brown Bears in the lower 48 states.

Grizzly populations still occupy only 1 percent of their original range in the lower 48 states and number fewer than 1,000 (Nowak 1999). This includes Yellowstone and Glacier National Parks, whose protection prevented their total extinction south of Canada, a few wilderness areas in Idaho, western Montana, and Washington. Human activities such as road building disturb them and cause them to desert otherwise prime habitat. They are no longer the fearless animals that Lewis and Clark encountered, but have become very shy outside of national parks after centuries of persecution. Although they may pose a potential threat to humans who enter their last retreats, people are a far greater threat to them.

Their rugged wilderness habitat in Montana is being developed rapidly, and Grizzly populations, which had risen somewhat after their listing on the US Endangered Species Act, are now in danger of disappearing again. Added to this, some ranchers in the region still persecute them. A prime habitat for Grizzly Bears, the 329,000-acre Swan Valley of northwestern Montana borders the Bob Marshall Wilderness area, a country of open grassland and forest with breathtaking mountain views. Until recently, this landscape remained almost unchanged from its original state. Ranching, road building and other activities, and an increasing human population in this region, however, are now ruining its wilderness character and threatening the Grizzlies (Pelletier and Servheen 1995). Through cooperation with local residents, the Fish and Wildlife Service is identifying important habitat areas and linkage corridors for the Grizzly Bears in this part of Montana to prevent conflict with humans. These zones would be a link between the small population of bears in the Mission Mountains to the west and those in the Bob Marshall Wilderness area (Pelletier and Servheen 1995). The land is a checkerboard of ownership by private individuals, state, federal and corporate entities; in an unusual project, all private and public lands will be included in a management plan, with input by local citizens (Pelletier and Servheen 1995). These bears remain under the continual threat of being shot by ranchers fearful for their livestock and apprehensive about possible land restrictions in areas where Grizzly Bears are resident. Sport hunting of this small population is also allowed.

Grizzly Bears are still depicted in the media as dangerous man-eaters, resulting in a prejudiced view by the American public. A number of television programs produced by the National Geographic Society, CBS, the Discovery Channel, Fox and others have perpetuated this image. With titles such as "Dangerous to Man!," "Bear Attacks" and "Man-eaters," these programs often demonize the bears and interview people who have been attacked while camping in the bears™ habitat. Very few such attacks have occurred, and almost none has been fatal. After centuries of being shot at and harassed by humans, Grizzly Bears tend to avoid people. When camping inside national parks where Grizzlies are resident, special precautions must be taken, and it should be kept in mind that the parks are *their* home, and humans are the intruders. The national parks, where hunting is banned, are their only refuge. Some documented cases of attacks have occurred when a mother bear felt her cubs were threatened by humans, especially if they approached the cubs. Mother Grizzlies may be the fiercest protectors of their young in the animal world, a trait that should be admired from a distance. Television programs that sensationalize the potential threat of animals do not note the hundreds of Grizzly Bears killed by humans every year in North America. They also fail to show the many bears that are merely wounded by hunters and suffer a long death, or the cubs that are orphaned and die of starvation.

The irrational fear and hatred aroused by misinformation often result in mortalities to these bears by armed tourists and residents in their range who misinterpret the bears' behavior. Many bears have had to be destroyed because tourists fed them, and they became fearless, capable of swiping food or destroying tents and property. Information on avoiding Grizzly Bear encounters is available from National Park Service rangers, other federally employed biologists, and many conservation and humane organizations. Only with tolerance, respect and an informed public concerned about preserving these bears can they survive.

Ecotourism in the threatened and unprotected portions of the Grizzlies™ range is in the early stages of development. Portions of the revenues from tours could be spent to acquire habitat and conduct local education programs. In Alaska, this has been highly successful, with tourists coming from around the world to see these bears fishing for salmon. Montana has some of the most spectacular scenery on the continent, sweeping vistas and vast open spaces that rival those of East Africa. They could be a magnet for tourists anxious to see Grizzly Bears and other native wildlife against a background of snow-capped peaks. Unfortunately, much of their prime valley habitats have been taken over by ranchers and private homes. The tourism in the area has been of a highly commercial and exploitative nature. For example, in some Montana towns, tourists see many stuffed Grizzlies in local businesses, and one can have one's photograph taken posed in a cutout painting of a Grizzly Bear appearing to attack.

If sizeable portions of Montana valley habitats were acquired for the Grizzly Bears, tourists could be taken on van tours, similar to those that now operate in East Africa. For the more athletic, groups of tourists could be taken on guided walks into the high country. Portions of the funds from the tours could be used to purchase privately owned land, to fund public education about these bears and their survival, and to compensate ranchers for livestock losses. The Nez Perce tribe is working with the Fish and Wildlife Service on a project to reintroduce the Grizzly Bear into the Selway Bitterroot wilderness of Idaho and Montana, another magnificent area for ecotourism (Robbins 1997).

Plans to reintroduce Grizzlies into the 1.9 million-acre San Juan National Forest in southwestern Colorado have sparked controversy and prejudice (Papich 2000). Decades after Grizzlies disappeared from the state, the Fish and Wildlife Service reintroduction project has been applauded by local conservation organizations, such as the Colorado Grizzly Project, and opposed by ranchers and even hiking groups who fear attacks (Papich 2000). Returning the Grizzly Bear to portions of its former range in the lower 48 states, even into immense wilderness areas, will be a slow process, possible only after extensive education and a change in the accepted practice of releasing livestock in national forests without sheepdogs, herders or other protections.

The Mexican Grizzly (*Ursus arctos nelsoni*) persisted in the remote mountains of northern Mexico until it was poisoned, shot and trapped to extinction in the late 1960s (Day 1981). This race was smaller than northern Grizzlies, weighing about 700 pounds. Quite numerous and widespread, the Mexican Grizzly had an enormous range in the pine forests of the northeast until efforts began to exterminate it. Only about 30 animals remained by 1960. Although some individuals tried to protect these last bears, others set out to destroy them, and a campaign of poisoning, trapping and hunting, sponsored by ranchers, resulted in the killing of the last animal in the early 1960s (Day 1981). In 1968, biologist Carl Koford conducted a three-month survey in the isolated mountain canyons of Chihuahua where they had last been seen, and he saw no sign of Grizzly Bears (Day 1981). Subsequently, they were declared extinct.

Hunters in many parts of the Grizzly Bear's range in Canada kill the species in such numbers that many biologists consider it to be threatened there. The Canadian Broadcasting Company's "Nature of Things" program produced a film, fiGrizzlies: Losing Ground,fl which painted a dim picture of this bear's future in Canada. They are killed by ranchers and hunted for trophies and for their gallbladders, which are used in Traditional Medicine. Many are killed by park rangers merely because they come too close to tourists. They are being driven from their wilderness homes by unrestricted logging and mining as well.

Brown Bears are already extinct in North Africa, Austria, Belgium, Denmark, Germany, Israel, Jordan, Lebanon, Liechtenstein, Luxembourg, the Netherlands, Portugal, Switzerland, Syria and the United Kingdom. They are

endangered in the few countries where they remain in Western Europe. In Scandinavia, there may be as many as 700 Brown Bears, with populations of less than 1,000 in Slovia, Romania and Bulgaria, and possibly 2,000 in the former Yugoslavia (Nowak 1999). Fewer than a dozen Brown Bears survive in France's Pyrenees Mountains where, despite protests from around the world, a major highway was built through the center of their habitat. Brown Bears are heavily persecuted throughout Eurasia for body parts, especially gallbladders. They are considered endangered in Central Asia's mountains where *Ursus arctos isabellinus* occurs, a CITES Appendix I race, and the Tibetan Brown Bear (*U.a. pruinosus*) is listed as Endangered on the US Endangered Species Act. Outside Russia, only about 4,500 to 7,600 of these bears remain in China, and isolated populations survive in Mongolia, northern Japan and Turkey (Nowak 1999).

The South American Spectacled Bear (*Tremarctos ornatus*) is classified as Vulnerable by the IUCN, with persecution by ranchers a major cause (Nowak 1999). These 300-pound black bears have large circles of white fur around the eyes and white circular markings on the neck and chest. They feed on fruit, bamboo hearts, corn, and other vegetation with about 4 percent of their diet composed of rodents and insects (Nowak 1999). Spectacled Bears are native to the Andes of western Venezuela, Colombia, Ecuador, Peru and western Bolivia. This high-altitude, shy bear is active mainly at dusk and at night and poses no threat to livestock, yet ranchers and landowners have persecuted and hunted it in Peru and other countries because of the mistaken belief that it kills livestock (Nowak 1999).

With the destruction of their high-altitude, humid forest and grasslands replaced in many areas by agriculture, some bears have raided corn fields to survive; many of these bears have been shot by farmers (Nowak 1999). This bear is declining throughout its range, and few areas remain where it can forage without being hunted, either by livestock ranchers, farmers, or for its body parts to sell to Asian markets for traditional medicine. Only a few national parks exist within its range, and populations have become fragmented and isolated from one another. A biological study of these bears in Bolivia by British zoologist Susanna Paisley is uncovering new information about their natural history and the threats posed by radio-tracking. A film about her study and the local people helping her, fiBears of the High Andes,fl was shown on a National Geographic Explorer television program in 1998, providing a unique glimpse into the lives of these rare bears.

Otters

The Eurasian or Common Otter (*Lutra lutra*) has been persecuted since the 13th century in Britain, and a dog, the Otter Hound, was bred to hunt it (Chanin 1985). This otter was officially designated as a pest by a 1566 English law, which authorized local constables to offer bounties for their destruction because of their supposed predation on fish (Chanin 1985). At that time, fish ponds on the estates of the wealthy were stocked to supply the tables of the affluent (Chanin 1985). They were also thought to be competitors with fishermen for game fish such as trout. For hundreds of years, high bounties were paid, contributing to their disappearance from many areas (Chanin 1985). Hunting otters with dogs was the only effective manner of pursuit, and in the 16th century, the Assembly of Norwich decreed that fishermen should conduct two or three otter hunts per year to avoid being fined (Chanin 1985). Estate game keepers continued over the centuries to persecute these playful animals in the British Isles, pushing them close to extinction.

In Europe, prejudices are gradually fading, but the Common Otter, despite its name, is no longer common. It has declined drastically in Britain and most of western Europe, and is rare throughout much of its range elsewhere in eastern Europe and Asia as a result of continued persecution, fur trapping, habitat loss and chemical contamination of its environment (Chanin 1985). This species is listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the category designating species in danger of extinction, and in which commercial trade is not allowed between the Party nations. The *2000 IUCN Red List of Threatened Species* classifies the species as Vulnerable. An increasing number of people are becoming acquainted with this delightful

animal. Not until 1978 did the otter receive official protection from hunting and trapping in England and Wales, and in the intervening years, a strong "Save the Otter" campaign, begun by Friends of the Earth, has had positive results (Chanin 1985). Surveys completed during the 1970s found that otters had become extremely rare in England, and were in steep decline. In parts of southwestern England, otters are now increasing with legal protection, and they are being reintroduced into areas where they had been hunted or trapped out. In 1982, protection was added in Scotland, in spite of continued opposition from otter hunters and those who harbored old prejudices (Chanin 1985). In the Netherlands, reintroductions of otters are returning them to long vacant habitat.

Izaak Walton's views of the otter were not scientifically refuted until the 20th century. Best known as the author of the 17th century book, *The Compleat Angler*, a compendium of information about fishing in England, he quoted a fishermen of the times: ". . . my purpose is to bestow a day or two in helping to destroy some of those villainous vermon; for I hate them perfectly, because they love fish so well, or rather, because they destroy so much, indeed, so much, that in my judgment, all men that keep otter-dogs ought to have pensions from the King to encourage them to destroy the very breed of these base otters, they do so much mischief." Scientific studies of otter diets established that these animals did not pose threats to game fish populations. A 1942 study found that North American River Otters (*Lutra canadensis*) prefer slow-moving forage fish, such as suckers, mudminnows and sticklebacks, to fast-moving trout. Some game fish are taken, but subsequent studies established that such fish make up a small percentage of the otter's diet. A 1955 study by biologist Richard Ryder examined stomachs of River Otters (*Lutra canadensis*) trapped in Michigan and found forage fishes (primarily mudminnows) in 56 percent, crayfishes in 22 percent, amphibians in 17 percent, insects in 13 percent, and trout in 13 percent of all otters examined. Ryder concluded that otters are opportunistic feeders, catching prey items in proportion to their abundance and in inverse proportion to their swimming ability. Thus they benefit game fish by removing overpopulated fish species that compete with trout for food from streams and waterways. In a dramatic demonstration to illustrate its food preferences, a River Otter was placed in a large tank with both trout and crayfish. Ignoring the fast-moving trout, the otter went directly for the crayfish.

Other species of otters also have been found to prefer slow fish, especially bottom-dwellers not desired by either sport or commercial fishermen. Yet they are still being persecuted in many parts of the world. The Marine Otter (*Lutra felina*), a small otter native to the Pacific coast of western South America, has been so persecuted by fishermen for alleged damage to fisheries (Nowak 1999) that it is now listed as Endangered on the *2000 IUCN Red List of Threatened Species*. The Sea Otter (*Enhydris lutris*), protected from previous hunting for the fur trade, began to recover its numbers in the North Pacific, but has recently declined to Endangered status as well as a result of persecution by fishermen, oil spills and predation by Killer Whales.

One young California Sea Otter filmed by Jacques Cousteau became very tame, cavorting with the cameramen and allowing itself to be petted. A few days after the Cousteau crew left the area, this young otter washed up dead on the beach, having been shot. It was conjectured that this friendly otter had approached a boat with fishermen who shot it. Fishermen have overharvested abalone beds for these extremely valuable mollusks and blamed Sea Otters for depleting them, yet abalone form only a small part of their diet. Some Sea Otters eat no abalone at all, specializing in other foods. Moreover, they eat sea creatures that prey on the kelp, without which abalone and other wildlife would not flourish. This species is considered a positive element in the ecosystem.

River Otters in North America were persecuted by European colonists, many of whom shot them on sight. These animals, described by early explorers as highly visible, bold and playful, became shy, secretive and nocturnal after centuries of persecution and fur trapping in the United States and Canada. By the 1950s, they had disappeared altogether from vast areas in the country, from Pennsylvania south to northern Georgia and throughout the Midwest south of Michigan and Minnesota, west to Utah (Nilsson 1985). Beginning in the 1970s, reintroductions of otters live-trapped in Canada, Michigan and other areas where they are still relatively common, have taken place in West Virginia, Arizona, Tennessee, upstate New York, Missouri and several other Midwestern states. In some cases, the reintroductions have failed, but for the most part, the North American River Otter is on the way to reoccupying its original range.

Otters are not regarded benignly by fish hatchery managers and commercial catfish farmers in the South. State Fish Departments and the Fish and Wildlife Service operate hundreds of hatcheries throughout the country, raising trout and other fish. Many of these are non-native species, such as Brown Trout, a European species, or native species, such as Rainbow Trout, that are released far from their natural ranges for the benefit of sport fishermen. These hatchery programs are regarded negatively by many ecologists who have documented that the released fish often cause great damage to ecosystems, outcompeting native fish and introducing diseases. Yet state and federal agencies conduct control programs on otters who raid their ponds. Rather than screen the ponds from otters, who can hardly be blamed for finding hatchery fish easy to catch, these authorities have had laws changed in many states to allow shooting and trapping of otters that come onto hatchery property. Placing screening over fish ponds and hatcheries--and fencing them--will prevent otters, as well as fish-eating birds such as egrets, herons, Ospreys and Bald Eagles, from preying on the fish being raised. This should be carried out instead of lethal methods, which also sometimes kill protected waterbirds. Such control programs do not achieve success in any case because even if depredating River Otters are killed, other otters will be attracted to the ponds, replacing those killed.

Eleven species of otters are listed by the *2000 IUCN Red List of Threatened Species*, four as Endangered, three as Vulnerable, one as Near-threatened, and three as Data Deficient. This represents a high rate of threat, 85 percent, as the otter, or Lutrinae family, has only 13 species. Otters tend to be thinly distributed in their ranges, wide-ranging, slow-reproducing and long-lived--all qualities that make them vulnerable to population declines.

Seals and Sea Lions

The Caribbean or West Indian Monk Seal (*Monachus tropicalis*) was the first animal seen by Christopher Columbus in the New World in the late 15th century, and his crew slaughtered these seals on an islet off the coast of Hispaniola (Day 1981). The only seals native to the Caribbean, they were quite large--6.5 feet long (Nowak 1999). They were heavily exploited beginning in the 17th century for their oil, which was used as a fuel for lamps and, later, for their fur. Scattered populations of the Caribbean Monk Seal survived on islets and beaches far from human habitation until the 20th century (Nowak 1999). Even these last seals were persecuted by fishermen who regarded them as competitors. The last known population of these seals lived on the Triangle Keys, small sandy islets off the Yucatan Peninsula of Mexico, and in 1911, fishermen slaughtered every one of the remaining 200 Monk Seals (Day 1981). Although a few seals were seen after that time, including the sighting of a small colony on a bank midway between Jamaica and Honduras in 1952, an aerial survey of all possible habitats carried out in 1972, and a 1980 expedition, failed to find any sign that the Caribbean Monk Seal remained alive (Nowak 1999). The species was officially declared extinct a few years later, although a few recent reports have given hope that the species may have reappeared (Nowak 1999).

The Japanese Sea Lion (*Zalophus californianus japonicus*), a subspecies of the California Sea Lion, was native to Japan, North Korea, and South Korea, and shooting by fishermen played a major role in its extinction (IUCN 1978).

Commercial fishermen have been responsible for the near-extinction of the Mediterranean Monk Seal (*Monachus monachus*). Once common along the coasts of the Mediterranean Sea, and along the Atlantic coasts of northwestern Africa, this seal is on the verge of extinction, its status listed in the *2000 IUCN Red List of Threatened Species* as Critical. Although resort and industrial development contributed to its decline, shooting by fishermen has been the major cause (Nowak 1999). Many seals drown when they become entangled in fishing nets as well. In past centuries, these seals could be seen on beaches along the Mediterranean, where they would have their pups. After severe persecution, however, they began to hide in the remote caves along the coasts and on uninhabited islets (Attenborough 1987).

In 1981, Greek fishermen threatened to kill off all the remaining Monk Seals on Greek shores if they were not paid compensation for the fish the seals would eat. The Fauna and Flora Preservation Society (now Fauna and Flora International), a London-based organization, raised the money after public appeals in newspapers, which amounted to several thousand dollars.
Fishermen throughout the region became even more intent on eliminating these seals after commercial factory fishing ships began to deplete fish stocks in the Mediterranean.

In spite of legislation protecting the seals, fishermen continue to shoot these seals, which are suffering from lost food supply in most areas. The once pristine waters are now overloaded with sewage and contaminated by chemical and oil spills (Attenborough 1987). The total population of this seal was fewer than 350 in the late 1980s (Attenborough 1987). A 1996 survey found 288 animals, mainly along the African coast in the Atlantic (*BBC Wildlife* 1996). Unfortunately, the largest population in the African islands was decimated in 1998 by a die-off, apparently caused by toxic chemicals.

Mediterranean Monk Seals are extinct in Cyprus, Lebanon, the Canary Islands and Syria, and probably extinct in most other Mediterranean countries. Researchers are conducting radio tracking studies of young seals to discover breeding calves with the goal of reintroducing the seals in the Canary Islands where they have been extinct for over 400 years (*BBC Wildlife* 1996).

The attitude that seals and other fish-eating animals are depriving humans of food is prevalent in many parts of the world and has resulted in the killing of countless fish-eating mammals and birds. The Marine Mammal Protection Act (MMPA) of 1972, which prohibits killing marine mammals in US waters, allows killing of "depredating" seals and sea lions under permit. Such permits are given to kill seals destroying nets to steal fish and/or having a deleterious effect on commercial fish species through their predation. Some Alaskan fishermen, who net the largest fish catches in the world, still resent that the fish are taken by seals and other marine mammals in their waters, and illegal shooting of these protected mammals frequently occurs. Sea lions along the coasts of California, Oregon and Washington have been shot illegally by the hundreds since the MMPA went into effect, and many permits have been given for legal killing. These killings have had a negative effect on many populations of these sea mammals.

Wild Cats
While it may be difficult for most Americans to think of the regal Cheetah as vermin, in the southern African country of Namibia, cattle ranchers treat these endangered and beautiful cats as enemies, trapping and shooting, and even poisoning them. White South Africans have acquired huge landholdings to raise cattle at the expense of the environment in this arid land, fencing off large sections from native wildlife. The majority of Namibian ranchers lack compassion or respect for this graceful cat and, without any compunction, kill females, young kittens and any adult Cheetah on their properties, whether or not the animals pose a threat to their livestock. One rancher told American conservationist Laurie Marker, who is seeking to reverse this trend, that he personally had killed 160 Cheetahs on his property. Marker has taken on the daunting task of trying to convince ranchers of the importance of protecting these endangered cats.

Cheetahs are the world's fastest land animal, reaching 70 miles per hour in pursuit of gazelles, foals of large ungulates, such as zebra and, occasionally, smaller mammals, such as hares. For hundreds of thousands of years, they have adapted to changes in the environment of their once vast range, and are superbly designed as predators. In the North American Pleistocene, more than 10,000 years ago, a cheetah-like cat ranged over the continent, preying on the Pronghorn, the world's fastest hoofed animal. This cat became extinct, perhaps as a result of hunting by Pleistocene hunters.

Prior to the 20th century, Cheetahs remained common in savannah habitats south of the Sahara, and in 1900, their population may have totaled 100,000 animals. Since then, a steady decline in their populations and a shrinking of their range have placed them in endangered status. Cheetahs underwent a dramatic decline in the 1960s when spotted cat fur became fashionable. US imports were stopped when the species was listed on the US Endangered Species Act in the late 1960s, and commercial international trade became illegal when Cheetahs were included on Appendix I of CITES in the early 1970s. Killing them for the fur trade devastated their populations because they are distributed so sparsely over their range--even a kill of a few thousand in each country endangered them. Added to this, they have endured persecution by livestock herders and ranch owners, combined with loss of savannah habitat and their prey species. In areas where there are large populations of Lion and hyena, adult Cheetahs and their cubs are preyed upon by the latter predators, who also steal their kills (Hunter 1998). Trophy hunting also has taken a toll on these cats.

By the early 1970s, they numbered only 15,000, according to Peter Jackson, head of the Cat Specialist Group of the World Conservation Union (Newman 1997). Cheetah biologist Luke Hunter (1998) estimates their total population today at a maximum of 12,000 animals, with safe populations in only five or six of the 26 countries where they may be present. In parts of southern Africa, Cheetahs were numerous until a few decades ago when white ranchers fenced off thousands of square miles of grassland. Within these ranches, which cover much of the land area in Namibia and Botswana, landowners killed off predators as well as native ungulates. The once abundant wildebeests, zebras, oryx, gazelles and antelope that migrated in the hundreds of thousands in this region became reduced to scattered numbers.

Namibia, with its arid, open habitat, still has about 2,500 Cheetahs, perhaps the largest population in Africa, but at the present rate of killing by ranchers, they will be extinct there within a decade. In the 1980s, 1,000 Cheetahs were killed by ranchers, and the Namibian Cheetah population dropped about 50 percent between 1984 and 1994 (Schick 1994).

A 1997 PBS television special, fiIn the Wild,fl featured actress Holly Hunter traveling to southern Africa in search of Cheetahs. A visit to Namibia's Etosha National Park, where these cats were once fairly common, failed to find a single Cheetah, in spite of expert help from native Bushmen trackers. An outbreak of Anthrax, spread by domestic livestock, had recently occurred in the park. Some 20 Cheetahs had died, and the disease also killed elephants and other wildlife.

Marker co-founded the Cheetah Conservation Fund in 1990, and since it has been in operation, it has changed many ranchers from Cheetah-haters to Cheetah-protectors. Few knew of the Cheetah's worldwide plight, and many cooperated when informed. One successful strategy to protect livestock introduced by Marker has been the use of donkeys to guard cattle herds. These animals easily fend off Cheetahs with their powerful kicking hooves (Schick 1994). Baboons have also been trained to guard livestock because of their aggression toward Cheetahs (Schick 1994). Recommendations such as bringing cows closer to homesteads during calving season have also been made to ranchers (Schick 1994). Many ranchers did not realize that Cheetahs prey on livestock only when their own natural prey, primarily gazelles and Impalas, have become scarce because of killing or fencing by the ranchers (Schick 1994).

Within the past few years, many ranchers have been convinced to use box traps to capture Cheetahs unharmed instead of killing these cats. Marker ear-tags the animals and returns them to local protected areas (Schick 1994), or arranges to have them moved. In the early 1990s alone, 75 Cheetahs were removed from ranches where they were being persecuted and were introduced into other areas. One farmer caught a female with five cubs and wanted to keep the cubs as pets. Marker convinced him to give up the female and four of her cubs, but he insisted on keeping the largest one. Although keeping Cheetahs as pets is not good for their welfare or conservation, it is an improvement over their wholesale destruction. Leghold traps are used by some ranchers, and in 1996 Marker acquired two 3-week-old Cheetah cubs whose mother had been killed in one of these traps. They will have to remain in captivity because of their young age when orphaned.

An organization known as Africat has sponsored the capture and transport of 100 wild Namibian Cheetahs to South Africa. This organization reports that ranchers capturing Cheetahs in large box traps often sell them to breeders rather than reintroduction programs, a practice that it does not condone. Translocating adult Namibian Cheetahs to South African reserves where they had become extinct has been very successful. In one case in 1995, three males were

released in Madikwe Game Reserve where four other Namibian Cheetahs had been introduced in 1994, and all survived. A male, four females and five cubs were released in Pilanesburg National Park in 1995, and there were no fatalities (*Oryx* 1996). Most of South Africa's Cheetahs were eliminated by Boers in the 19th century, and the government is now returning them to their original range within national parks. Outside of national parks, they may be in as great danger as the Cheetahs further north.

Lions have continued to decrease in Africa south of the Sahara from a variety of factors, of which persecution by livestock raisers is a major one. Outside of national parks, these big cats have become rare or absent, and in 1996, the species was first listed by the IUCN as Vulnerable. The *2000 IUCN Red List of Threatened Species* also classified the African Lion as Vulnerable. They disappeared long ago from areas with scarce ungulate populations and large numbers of herdspeople who persecuted them, such as the arid regions of southern Africa and the sub-Saharan. In recent years, they have declined throughout the continent. Outside of parks, the Maasai and other tribes with livestock herds routinely kill Lions and other predators to protect their cattle (Hunter 1998). Lions are particularly vulnerable to persecution and hunting because, like wolves, they hunt in groups. When persecuted, they may not be able to survive hunting alone or in pairs.

Some parks are not large enough to maintain healthy Lion populations, and when they leave parks to wander in search of prey, they are often killed by ranchers or hunters. In the southern African country of Namibia, for example, the 300-mile-long, 25-mile-wide Skeleton Coast National Park skirts the Atlantic coast. Two filmmakers, Jen and Des Bartlett, chronicled the disappearance of Lions from the park. A small population of Lions inhabited the park in the early 1990s, and one pair was radio-collared by park rangers. Shortly thereafter, both Lions were shot dead by livestock herders when the Lions left the park. The Bartletts had known the female for five years, and she was pregnant with four cubs when shot. The killing of Lions to protect livestock is legal in Namibia, and with the death of the last specimen in the park, an elderly and emaciated animal shown in their National Geographic Society film, fiSurvivors of the Skeleton Coast,fl these great cats are now extinct in the area.

Wild cats have been hunted heavily and killed off throughout the Middle East. Leopards (*Panthera pardus*) still persist in small pockets, escaping detection with nocturnal hunting, and hiding in rock crevasses and trees during the day. As a general rule, wherever Leopards are seen in the Middle East, they are shot or poisoned as potential threats to the ubiquitous sheep and goats. In a few areas, such as remote portions of the Saudi Arabian Peninsula, Leopards are protected in national parks. These Leopards are very adaptable in their prey and can subsist on small animals, such as hares--unlike the Lion, which requires larger prey.

Eight subspecies of Leopards are listed on the *2000 IUCN Red List of Threatened Species*, all in Endangered or Critical categories. They range from North Africa across Asia to Java, Indonesia. Races such as the South Arabian Leopard (*Panthera pardus nimr*) of Saudi Arabia, United Arab Emirates and Yemen; North Persian (*P.p.saxicolor*) of Afghanistan, Iran and Turkmenistan; and the Anatolian Leopard (*P.p.tulliana*) of Turkey, have populations so small that they may become inbred and disappear within a few decades. The South Arabian Leopard is the focus of a conservation program organized by officials and conservationists from Saudi Arabia, Yemen, Oman and the United Arab Emirates. Only 100 to 200 of these cats survive, and they continue to be persecuted by livestock owners and hunters (*Oryx* 1996). The "Leopard Group of Arabia" was formed in 1995, and each country will prepare a plan for conservation of the Leopard, review its own wildlife legislation, conduct surveys, and make proposals for protected areas (*Oryx* 1996). This group is also working to increase populations of native prey, reduce livestock numbers in the Leopards™ habitat, and conduct public education programs (*Oryx* 1996).

Snow Leopards (*Panthera uncia*), native to the mountains of Asia, from Pakistan east to China, are endangered from hunting for pelts and as trophies, and by persecution from herdsmen who kill them as a threat to their livestock. Their total population may be as low as 4,500 or as high as 7,500 (Sunquist 1997). In their stark, rocky and high desert habitats, these cats prey upon wild sheep, goats, deer and marmots (Sunquist 1997). Their original range stretched for 4,000 miles and encompassed 1.2 million square miles in a wide arc, curving from east to west in the Himalayas through former Soviet Republics, Nepal, Pakistan, Afghanistan, Bhutan, Sikkim, and Mongolia to China, including a

total of twelve countries (Baillie and Groombridge 1996). They have disappeared from vast areas within this region, however, and continue to decline.

Until the 20th century, few herdspeople roamed these remote and forbidding regions, and Snow Leopards and their prey were left unmolested in most areas. In the past 50 years, however, human populations have risen dramatically. In western China, the government has used subsidies to encourage settlement of the western steppe, and large numbers of people have entered previously uninhabited areas with their livestock. In western Nepal, villages now dot the Himalayan slopes at 9,800 feet, and people scratch out a living from meager potato, barley and wheat crops (Sunquist 1997). Each household has only a few sheep and goats and cannot afford to lose even one to predators (Sunquist 1997).

Some 1 million Mongolian herders subsist in a barren landscape, dependent on their yaks, goats and sheep. These people, whose livestock compete with wildlife for the scarce grasses, also hunt native animals which the Snow Leopard needs to survive--Blue Sheep, ibex, deer and others. Even marmots are killed in very large numbers for their meat and skins (Sunquist 1997). When their natural prey disappears, and Snow Leopards begin to prey on livestock, herders poison, trap or shoot these cats in retaliation. In many areas, herders kill Snow Leopards as a potential threat, even when they have not lost livestock, in order to sell their valuable pelts.

Dr. George Schaller of the Wildlife Conservation Society has conducted studies on the diet of Snow Leopards and, in most areas, found less than 5 percent of livestock in their diet, based on feces analyses (Schaller 1998). As numbers of livestock in the Snow Leopard's range rise and herders penetrate further into the mountains and high pastures, livestock losses occur that sometimes result in extermination campaigns (Schaller 1998). Herding practices in these areas often encourage predation by Snow Leopards, with sheep and goats, and mares with their foals left unguarded (Schaller 1998). Depletion of their prey has increased in recent years, with government policies that encourage marmot hunting, pika poisoning and, until the late 1980s, Blue Sheep market hunting (Schaller 1998).

In Tibet, Dr. Schaller has arranged with local herdspeople to pay them for any losses they incur to Snow Leopard predation, and he has hired local Tibetans to assist in field studies of these cats, giving them a financial incentive to protect the cats. Likewise, in Pakistan, a new program organized by an American conservationist, Helen Freeman, founder of the Seattle-based International Snow Leopard Trust, has sponsored some 90 projects for the species, including many field studies. Its web page (www.snowleopard.org/islt) follows the movements of radio-tracked Snow Leopards. Gary Larson, the popular *Far Side* cartoonist, created a Snow Leopard design for the organization to use on its shirts (Sunquist 1997). Grade-schoolers all over the country have raised money by selling T-shirts for the International Snow Leopard Trust. In 1988, through the education programs and compensation for livestock losses conducted by this organization, a Pakistani livestock owner trapped a young Snow Leopard found preying on livestock, contacted the government and, before news crews, set it free. In the past, it would have been killed routinely.

The International Snow Leopard Trust and the Mongolian Association for Conservation of Nature and Environment are providing tea, noodles and clothing to livestock grazers in Snow Leopard territory in the Altay Mountains of Mongolia, with the understanding that they will protect wildlife (Schaller 1998). One village requested children's clothing, flour, candles, soap and tea, and these requests were filled (Sunquist 1997). The concept of involving local people in the conservation of wildlife is extremely important and, wherever practiced, has had beneficial long-term results for all concerned.

Bats

Bats live on every continent except Antarctica and serve extremely important ecological roles as pollinators, seed

dispersers and consumers of vast quantities of insects. Although some societies value these useful animals, many persecute all bats, based on irrational prejudice and fears of rabies. The Romanian legend of Dracula, in which a man turns into a blood-thirsty vampire bat at night and flies about seeking victims, has created a ridiculous and false impression. Real vampire bats are small, only about 3 inches in length and weighing about an ounce (Wilson 1997). The three species inhabit neotropical forests and are rare in natural habitat. Only when large numbers of livestock are grazed in an area do these mammals, who suck blood from large animals such as livestock, become common (Wilson 1997). They rarely cause the livestock harm. They are capable of transmitting disease to their host animal, but very rarely do so (Wilson 1997). Bat Conservation International has worked effectively to allay fears about vampire bats and helped many people to see them in the positive light of their value to ecosystems, economies (through pollination), seed dispersal and insect control and their interest as diverse, successful species. But Dr. Merlin Tuttle, founder and Executive Director of the organization, believes that persuading the public that bats are not to be feared is still an uphill battle, in spite of progress made in education programs (Raver 2001). Exaggerated headlines about bats and rabies tend to undo rational education programs. In fact, Dr. Tuttle says that over the past 20 years, the United States has had 1.5 human cases of bat rabies per year, hardly deserving the hysteria that so many people feel at the mere mention of bats (Raver 2001).

One positive change in recent years is the increase in people who rise to the defense of bats when newspaper stories appear about the threats of vampire bats and bat control in buildings (Garvin 1999, Gross 2000). Letters to the editor often make the point that bats are basically beneficial, and articles depicting them as fearsome enemies are misleading and cause persecution of wild bats. One article in *The New York Times* (Gross 2000) profiled a bat control professional who paid house calls when people complained of bats having entered their homes. He set glue traps, which bats blundered into and then broke their necks, and sent their bodies to a laboratory in the state capital for rabies testing (Gross 2000). Experts have found that only 1 to 4 percent of bats are rabid, and conservationists suggest that bats be set free rather than killed (Gross 2000). A more humane approach to the problem of bats in the attic was developed by Cal Kosky, a wildlife biologist with the Pennsylvania Game Commission. He tapes a piece of plastic or netting over the top of the entrance hole on the outside of the house (Raver 2001). Bats are able to fly out, but are blocked on return. A bat house is placed strategically close to the old hole to provide them with a new home (Raver 2001). Bat Conservation International has an educational video, "Building Homes for Bats," which explains how to construct bat houses to attract bats to backyards where they eat mosquitoes and other insect pests (Raver 2001).* Sensible advice can also be obtained from Dr. Tuttle's 1988 book, *America's Neighborhood Bats. Understanding and Learning to Live in Harmony with Them*.

Prejudice against bats has had serious consequences for many populations that roost in accessible places, such as open caves. The largest bat colony in the United States, located in Eagle Creek Cave in Arizona, had 30 to 50 million individuals until the 1960s, when vandals and human disturbance reduced them to only 30,000 (Wilson 1997). Several species of North American bats have become endangered as a result of deliberate killing by people, disturbance by spelunkers, and tourists entering the caves (Nowak 1999). The Gray Bat (*Myotis grisescens*) and the Indiana Bat (*Myotis sodalis*) of the eastern and Midwestern United States, for example, are both endangered as a result of these activities. Dr. Tuttle has found that the total number of Gray Bats in 22 major summer colonies declined from 1.2 million prior to 1968 to 293,600 in 1976, a loss of 75 percent (Nowak 1999). The Indiana Bat fell from 640,361 in 1960 to 459,876 in 1975; by 1993, 347,890 remained (Nowak 1999). Both species are listed as Endangered by both the *2000 IUCN Red List of Threatened Species* and the US Endangered Species Act. In Europe, the Pond Bat (*Myotis dasycneme*), a related species, has been reduced to only 3,000 in western Europe and fewer than 7,000 in its entire range (Nowak 1999). It is listed as Vulnerable by the IUCN. Many other European myotis bats also have declined to Endangered or Threatened status from habitat loss, disturbance of hibernating colonies in caves and mines, and blocking up of nursery sites in large buildings, such as cathedrals and castles (Nowak 1999). Rather than killing bats that roost in buildings, or blocking up entries, Bat Conservation International encourages the placement of bat houses nearby, which the bats tend to occupy instead. Similar efforts are needed in Europe. Even when allowed to roost in buildings, many bats are poisoned by chemicals used to treat wood in western Europe (Nowak 1999).

Bat caves are often vandalized when bats hibernate in the winter. Vandals enter caves and knock semi-conscious bats

to the ground, killing them by the thousands, or even millions. Even entering a hibernation cave can result in mortality because disturbances can arouse them and they use up so much stored energy that they do not survive the winter (Wilson 1997). Many bat caves now have gates that allow bats to fly through the open grating, but keep people out; they have helped protect important bat hibernation areas where bats from large areas congregate (Wilson 1997).

The importance of bats as pollinators is discussed at length in *The Natural History of Pollination*, by Michael Proctor, Peter Yeo and Andrew Lack (1996). Many types of flowers have evolved to be pollinated by bats, opening only at night. Their internal pollen-carrying structures are designed to drop pollen on the bat's face when it feeds on nectar (Proctor *et al*. 1996). A great variety of bats and plants coexist, perfectly adapted to one another. Dr. Tuttle's dramatic photos of many such flowers have been published in *National Geographic* magazine and in the useful book, *Bats in Question. The Smithsonian Answer Book* (Wilson 1997). He also has made films of bats for nature documentaries. Many bats are extremely attractive, and their sonar is so complex and sensitive that it is only partially understood by scientists. *Walker's Mammals of the World*, by Ronald Nowak (1999), is another important source of information on bat biology, taxonomy, behavior, conservation and related subjects.

After rodents, bats have the greatest number of species of any mammals, with the most diversity in tropical areas. The number of threatened species has increased dramatically over the past decade as a result of persecution, killing for food, pesticides and other toxic chemicals, and loss of their habitat (see Appendix for list of threatened species). The majority of species at risk suffers from a combination of these factors.

*This video can be ordered online at www.batcon.org or by calling 1-800-538-BATS.

Birds of Prey

Birds of prey have been persecuted for hundreds of years in Europe and other parts of the world, usually as suspected predators of chickens or small livestock, such as goat kids or lambs. In most parts of the world, they still are given no official protection.

Hawks, eagles, owls, falcons and other birds of prey that breed in North America were excluded from the 1918 Migratory Bird Treaty Act (MBTA), signed with Great Britain on behalf of Canada. The Treaty covered almost all other species of native birds, banning hunting and killing as well as harassment and destruction of nests. This exposed birds of prey to continued indiscriminate shooting for sport, hunting from aircraft, poisoning and even capture in pole traps, which catch birds by the feet and hang them upside down in nooses.

Populations of birds of prey that breed in Canada and the northern United States migrate south during the fall, some to Latin America and others to southern states. Flying along thermal wind currents, they funnel into flyways as they pass through mountain chains. In the eastern United States, thousands of hawks, and a smaller number of eagles and falcons, pass over the Allegheny Mountains of Pennsylvania during October, November and December every year. Kittatinny Ridge, near the town of Kempton, came to be known as Hawk Mountain because of the huge numbers of birds of prey passing near it. For generations in the 19th and early 20th centuries, hunters gathered every fall on the rocky ridge to shoot these birds by the hundreds as they soared by. Dead hawks, falcons and eagles accumulated in huge piles, while wounded birds staggered around or lay helplessly immobile on the ground (Brett 1973).

This carnage was considered a form of sport, justified by old prejudices. Rosalie Edge, an ardent conservationist, spearheaded the movement to stop this hunt in the 1930s (Brett 1973). This courageous woman publicized the slaughter of birds of prey, and after a campaign in which she enlisted the help of influential conservationists, she succeeded in purchasing the mountain as a sanctuary (Brett 1973). Edge persuaded an ornithologist, Maurice Broun,

and his wife, to oversee the sanctuary and prevent hunting. They remained on Hawk Mountain for 32 years and served as guides for the more than 40,000 visitors who come every year to see the spectacle of hawks flying over and alongside the mountain ridge (Brett 1973). Rosalie Edge died in 1962, but the sanctuary continues as a non-profit organization staffed with ornithologists, educators, and volunteers, who chronicle by species and number the birds that fly past the ridge.

Hawk Mountain Sanctuary is one of the country's first examples of private ecotourism, and it has accomplished a great deal in teaching the public about birds of prey as useful animals in ecosystems, as well as providing exciting views of these birds as they soar past the ridge. In the morning, before the thermal winds warm up, hawks fly at low elevations, giving visitors a view of their tails and backs from above, an especially colorful sight in the case of the Red-tailed Hawk (*Buteo jamaicensis*), while in the afternoon, they fly higher, transported along by the thermals. Sometimes a visitor to Hawk Mountain can see a hawk or other bird of prey at close range, only 15 or 20 feet away, as they fly close to the ridge, the intricate patterns of their feathers in full view.

In spite of the preservation of Hawk Mountain and several other key hawk habitats, legal protection from hunting did not come in the United States until 10 years after the death of Rosalie Edge. During these years, thousands of hawks and other birds of prey were shot because of ignorance or as sport. Little was understood about their value in controlling rodents and rabbits. In 1960 alone, 12,000 Golden Eagles (*Aquila chrysaetos*) were killed in Texas in a massive campaign to eliminate them. A major victory for birds of prey was their addition to the Migratory Bird Treaty Act in 1972. The bans on hunting that have protected other native land birds were finally accorded these raptors. This was carried out through a memorandum enacted with Mexico, which had signed the Migratory Bird Treaty Act in 1936. It prohibits, except as allowed under specific conditions, the taking, possession, purchase, sale, or bartering of any migratory bird, including the feathers or other parts, nests, eggs or migratory bird products. "Taking" is defined as pursuing, hunting, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, or collecting migratory birds. Individuals and organizations may be fined up to $5,000 and $10,000 respectively, and those convicted may face up to six months imprisonment for misdemeanor violations of the Act. Felony violations may result in fines of up to $25,000 for individuals and $500,000 for organizations and up to two years imprisonment for those convicted. This strong legislation has not stopped the killing of birds of prey altogether, but it has deterred the type of slaughters that were once common.

Although Bald Eagles were revered by native tribes, especially those in the Pacific Northwest, they became victims of prejudice by European colonists, who accused them of damaging fish stocks. A bounty in Alaska resulted in the killing of some 150,000 of these eagles between 1917 and 1953. This species is the national bird, the official symbol of the United States of America, yet historically it has been given little respect. Some even called them "gangster birds" because they were thought to be scavengers of fish caught by other birds. In truth, they are superb fishers with extraordinarily keen vision and are acrobatic in flight. Bounty programs and random shooting of Bald Eagles from colonial times onward caused these birds to disappear from much of their original range, which encompassed the entire continent of North America, including arid regions in the Southwest.

The Bald Eagle Protection Act was enacted in 1940 to protect it from extinction, and amended in 1962 to extend protection to Golden Eagles, primarily to protect immature Bald Eagles, which resemble them. A 1972 incident involving the slaughter of hundreds of Golden Eagles by western ranchers shooting from aircraft resulted in increasing fines under the law from $500 to $5,000 and/or one year imprisonment for subsequent offenses. The amendments also specifically included poisoning in the definition of taking, since both Bald and Golden Eagles had been poisoned by ranchers. These amendments also included the same high penalties for possession of eagle feathers, nests or eggs, and made federal grazing permits subject to cancellation for violations of the Act. In addition, they added a new facet to the enforcement of the Act: one-half of any fine can be paid to a person who provides information leading to a conviction. To augment this protection, the Airborne Hunting Act was enacted in 1972 to prevent the killing of wildlife from aircraft.

After 1973, the killing of a Bald Eagle constituted a violation of the US Endangered Species Act, the Bald and Golden

Eagle Protection Act, and the Migratory Bird Treaty Act, the combined penalties of which could amount to long jail sentences and very high fines. In spite of all these legal steps taken to protect eagles, killings continue. Many are deliberate and carried out in remote areas where there is little fear of prosecution, and others are done by hunters ignorant of the law or the identity of their targets. The protection of native birds, their identification, and laws applying to them should be taught in schools in North America, but such information is usually acquired by chance if at all. Each year, 300 to 400 eagles--Bald and Golden--are found dead. In some cases, hunters still believe folklore about birds of prey being destructive, and shoot them intentionally. A Bald Eagle shot in Maine in 1994 was killed by an 85-year-old man who deliberately killed the bird because he believed these birds were killing geese. He told game wardens that they should "do something about the eagles;" because of his age, he was only given a $2,500 fine, which was suspended. Bald Eagles feed mainly on fish and are not major predators of waterfowl.

Although the majority of eagles are killed when shot, many are found wounded, some in emaciated condition, unable to fly to obtain food and near death. One such Bald Eagle was found crippled in 1983 in Georgia, having been shot in the wing. He had been on the ground for a week, his wing bone exposed. In spite of attempts to save his wing, veterinarians had to amputate it because of infection, and the eagle was taken into a rehabilitation program. Named Osceola, he has played an important role in Wings of America, an education program at Dollywood in Tennessee. John Stokes, Osceola's caretaker, teaches children and adults about the effects of such shooting, stressing the impoverished life that Osceola leads, unable to fly and be free. Stokes decided to bring Osceola along on his hang-gliding trips to treat the bird to some of the sights the eagle had not seen in the many years since being shot. Harnessed into a specially made sling, the pair hang-glided, with Osceola positioned above Stokes, looking intently at the ground far below, turning his head frequently in apparent fascination. The film of Osceola hang-gliding was shown on nationwide television in 1996, and some 500,000 people attend lectures featuring this maimed eagle every year. The National Audubon Society series for young people, "Audubon's Animal Adventures," featured Osceola in the program entitled "Eagle Adventures," shown on the Disney channel.

In the past, it was impossible to prosecute offenders unless there were witnesses or other direct evidence to the killing. Today, a state-of-the-art forensic laboratory run by the US Fish and Wildlife Service in Washington state is able to necropsy dead eagles for cause of death. If shot, ammunition extracted from the birds is analyzed forensically, and cases are made with as much precision and scientific evidence as criminal investigations in which people are the victims.

Prejudices against birds of prey still persist among many who wrongly believe that they harm wildlife or present major threats to domestic animals. Biological studies have documented their ecological importance as major controls on rodent populations. Some birds of prey feed on snakes, insects or other potential pests. No species of raptor poses a significant threat to domestic animals.

The continent's densest population of birds of prey breeds in the craggy canyons and sagebrush shrubland of Idaho. This area has been set aside as the Birds of Prey National Conservation Area, lining 81 miles of the Snake River and covering 485,000 acres. Prior to its protection, this land was in the process of being converted to agriculture. The birds of prey had begun a steep decline from shooting and loss of habitat. Conservationists faced strong opposition to the plan, but overcame it, establishing this area in 1971, a year prior to the inclusion of birds of prey on the Migratory Bird Treat Act. It has since become a leading ecotourism destination for rafters and hikers, who are led on tours by naturalists from the Bureau of Land Management (BLM), which oversees the refuge. Fourteen species of raptors breed in the area or migrate through it, and the breeding population of hawks, eagles, owls and falcons has been estimated at 800 pairs. They provide exciting views of high-speed hunting of ground squirrels and birds, and their eerie shrieks resound through the canyons.

Waterfowl hunting is regulated by the Migratory Bird Treaty Act under regulations by the Fish and Wildlife Service. Unfortunately, the regulations have serious shortcomings that have resulted in many shootings of birds of prey. First, hunting can begin before dawn, when hunters are unable to identify birds by species. Each year, hundreds of birds of prey, including such endangered species as Peregrine Falcons, are shot accidentally. Second, the regulations do not

require that hunters be able to identify birds by species, including protected and endangered species. Since many ducks and geese are extremely difficult to identify, the failure of the Fish and Wildlife Service to require hunters to pass identification tests and begin hunting well after daybreak means that protected and endangered birds will continue to be shot.

In October, 1995, a Peregrine Falcon (*Falco peregrinus*) shot in Massachusetts was migrating south from Canada or Greenland during hunting season. It suffered neurological damage after being shot in the left wing while it was flying in a wildlife refuge area. The Assistant Director of the State Division of Fisheries and Wildlife, Tom French, stated that it appeared that the bird was not shot accidentally. This was the second shooting of a Peregrine Falcon in as many years. The reintroduction of captive-bred specimens of these birds into the eastern United States has been a success, with over 130 nesting pairs. Their long-term survival, however, will depend on adherence to laws prohibiting shooting or harming them.

For the future, the Migratory Bird Treaty Act would be far more effective if signed with Latin American and Caribbean nations to protect North American birds wintering in those countries. This would be especially important in view of the decline in many of the continent's birds of prey, which are persecuted and killed by pesticides and poisons in their wintering grounds.

The California Condor (*Gymnogyps californianus*), North America's largest bird of prey, once soared over most of the continent. Its bones have been found among Florida's Pleistocene fossils, and 20,000 years ago, it was very common and widespread, feeding on the carrion of mastodons, bison and other large mammals. This giant bird's superb aerodynamic flight makes the most sophisticated man-made aircraft look clumsy by comparison. Condors have a positive role to play in ecosystems, feeding on carcasses and thereby ridding the environment of these potentially infectious contaminants. Although they declined in range over the centuries, condors were still widespread from Baja California, Mexico, north to Washington state, where Lewis and Clark saw them along the Columbia River in the early 19th century. They were often observed scavenging seal and whale carcasses along the California coast, and they nested as far east as the Sierra Nevada Mountains.

Settlers looked on condors as large targets, with their 10-foot wing span, and perhaps thought they were predatory birds. Hundreds were shot. These birds feed exclusively on carrion and do not hunt live animals. When word spread in the last years of the 19th century that the condors were approaching extinction, egg and specimen collectors preyed on the remaining birds. Between 1881 and 1910, 288 birds were killed as museum specimens (ICBP 1981). By the turn of the century, only a few hundred birds remained, yet killing was still legal. The ornithological journal *The Condor* began publication at this time and recorded many instances of these killings. In one case, an individual named Frank S. Daggett reported shooting a California Condor in 1901, wounding it in the wing and then, when it fell to the ground, shooting it three more times, still not killing it. Finally he clubbed it and shot it yet again before the bird died (Daggett 1901).

The California Condor continued its decline until only 60 birds remained in 1939 (Greenway 1967). The last population survived in a wilderness area of southern California. In spite of legal protection and the establishment of the Sespe Condor Refuge, the birds suffered high mortality from shooting, ingestion of lead shot from deer killed by hunters, feeding on animals killed by predator poisons, collisions with power lines, and accidental capture in leghold traps. Biologists from the Fish and Wildlife Service and the National Audubon Society were assigned to study and protect this small population in the 1960s and 1970s, but they did not publicize its precipitous decline or insist on further protection from the threats that continued to kill these birds. As these birds headed toward imminent extinction, nothing was done to stop deer hunting in their refuge, nor to prevent the use of steel jaw leghold traps or predator poisons in their diminishing range.

One of the last nests was in a regal setting befitting this massive bird: a huge natural hole in a giant, old Sequoia tree. The eggs from this nest and others were taken by the Fish and Wildlife Service for captive hatching. In 1980, one of the last wild chicks hatched in a cave and was being weighed and tested by biologists when it suddenly died. It had

been handled for more than an hour, during which time it repeatedly hissed and jabbed at the researcher. Later it was revealed that shock caused its death. The incident was filmed and shown on national television, resulting in the cancellation of the recovery program by the state of California, followed by a long period of re-evaluation and controversy. By 1981, the state reached an agreement with the Fish and Wildlife Service to allow capture of the last nine California Condors, but the program was delayed by lawsuits and wrangling over details. By the time it was finally decided to capture all remaining condors in 1987, only six survived (BI 2000).

The sad decision to remove all wild California Condors turned out to be the correct path to preserve the species, since its wide-ranging behavior exposed it to countless perils that were beyond the control of its protectors. To the amazement of many, the captive-breeding program succeeded beyond all expectations. The eggs laid by the captive condors were artificially incubated, and chicks were fed by workers, with puppets resembling adult condors covering their hands. So many birds were captive-bred at special facilities run by the Los Angeles Zoo and other breeding centers that by 1992, a reintroduction program began with release of captive-bred birds into the wild in southern California. Some of the released birds died after striking electric power wires or were injured and had to be returned to captivity. Several landed in suburban locations, perching on the decks and roofs of private homes and even, in one case, entering someone's home. Most residents did not recognize the birds™ great rarity and protected status, and put out food, such as hot dogs, for them. Finally, wildlife authorities and television news stations learned about the situation, and many Californians became aware of these giant and extremely rare birds. To many ornithologists, the behavior of these young condors indicated that the birds were tame and considered humans a source of food. The puppets apparently had not fooled them into thinking they were being fed by parent birds.

By July 1994, California Condors numbered 89 birds, 85 of which were in captive-breeding facilities, and four released birds (Collar *et al*. 1994). Six young condors were released in the Grand Canyon area in late 1996, with Fish and Wildlife Service personnel staying close to provide food and to radio-track the birds. Within a short time, one of the condors was killed by an eagle, an unexpected setback. The total California Condor population grew to 120 birds by early 1997, and only a year later it had increased to 147 birds, of which there were 97 in captivity, 28 returned to the wild in California's Los Padres National Forest, and 22 released in Arizona (BI 2000). The released birds are provided with livestock carcasses until they are able to find food on their own. The success of this program has not yet been proven by breeding in the wild, as all released birds are too young. Only time will tell whether these birds survive and reach the goal of 150 birds in separate populations. They are being trained to avoid some of the sources of mortality that killed them in the past, such as power lines, but as long as lead shot is used in deer hunting in their range, this will remain a potential threat to them.

Elsewhere in the world, birds of prey receive little or no protection from persecution. In Italy, shooting of migrating birds of prey has long been a "sport" in which gunners position themselves in concrete bunkers on hillsides and kill hawks, falcons and eagles as they fly by. One woman decided to fight the hunters and worked successfully for an official ban on shooting these birds. In spite of this, illegal shooting takes place in Italy, and every year during the migration season, conservationists from many parts of Europe come to help her enforce the ban. The campaign to stop hunting of these birds was described in a film, fiAnna and the Honey-Buzzardsfl (see Video section). In Australia, persecution of eagles and hawks is rampant. After shooting these birds, especially Wedge-tailed Eagles, they are often nailed to fence posts with their wings spread. Few of the ranchers who kill thousands of these birds seem aware of the important role they play in controlling rabbits.

Snakes

The prejudice against snakes may be traced in some cultures to the Biblical story of Adam and Eve, in which the snake represents the evil temptor. For many, snakes inspire great fear and loathing, and they are often killed upon sight. In the American West, rattlesnake hunts are carried out in many towns as an annual event, with thousands of

snakes captured. After being prodded and manhandled, they are killed, often by being skinned alive. The New Mexican Ridge-nosed Rattlesnake (*Crotalus willardi obscurus*) is a threatened species on the US Endangered Species Act, persecuted and overcollected in its limited range. In Eastern states, especially in the South, snakes are also hunted for sport, burned alive with gasoline poured down their dens, and killed in bizarre religious ceremonies. One town in Georgia has an annual war on rattlesnakes, killing as many as possible. For some species, this has resulted in serious declines. The Eastern Timber Rattlesnake (*Crotalus horridus*), the largest snake native to the United States, inhabits forested areas with rock faces, crevices and caves in the Northeast. It has become threatened in many parts of its range. These snakes, which range in size from 35 to 74 inches in length, are vulnerable to persecution because they congregate in large numbers in rocky dens and overwinter with other types of snakes for warmth. They hide under rocks where hunters and collectors find them. Timber Rattlesnakes are long-lived, known to survive 30 years or more. Females give birth only every other year, do not mature until age 4 or 5, and have only 5 to 17 young (Behler and King 1979). With such slow reproduction, they are vulnerable to declines when hunted.

This species has legal protection from hunting in Pennsylvania and New York and is listed on their state endangered laws, yet hunting still kills hundreds each year. One rattlesnake hunter, profiled by CNN, bragged that he had captured 9,000 Timber Rattlesnakes in his lifetime and planned to continue openly flouting laws protecting the species. He claimed that he enjoyed catching and killing these snakes so much that he would never stop, and some herpetologists accuse this man of single-handedly causing declines. He has been arrested many times and jailed for trading in endangered species, but refuses to stop. These snakes do not pose a threat to people unless they are sought out in their retreats.

Biologists point out that snakes are extremely useful ecologically, feeding on squirrels, mice, rats and other rodents, but since laws in the United States and around the world either fail to protect snakes or are not enforced, snakes often are persecuted and killed senselessly.

Rodent Control

Prior to settlement of North America, prairie dogs of many species inhabited towns of burrows that covered some 98 million acres of shortgrass prairies, from southern Canada to Mexico. One prairie dog town in the Texas Panhandle stretched over 25,000 square miles and held an estimated 400 million animals (Dold 1998). Prior to the 19th century, they are thought to have numbered 5 billion animals (DeBlieu 1993). These towns have since been destroyed, the prairie dogs killed, and the habitat used for agriculture, pastureland and development. A keystone species, prairie dogs create habitat for hundreds of other animals who live in their complex burrow systems. These rodents have been driven to endangered status after centuries of persecution and poison campaigns that were based on the belief by cattle ranchers that prairie dogs ate too much grass, depriving cattle of fodder. The US government sponsored the destruction of prairie dog towns beginning in 1900. The poisoning program was bolstered by inaccurate information from the US Biological Survey, which stated in 1902 that prairie dogs decreased productivity of grasslands by 50 to 75 percent (Dold 1998). Poison bait was distributed in the towns, gasoline was poured into their burrows and set afire, and they were shot by the thousands. A highly toxic poison, 1080, was used from the 1960s on, devastating prairie dog towns and killing vast numbers of animals, from foxes to Golden Eagles, who fed on the poisoned prairie dogs. This reduced prairie dog habitat to about 1.5 million acres, a fraction of their original range.

Modern biological research has unveiled the truth about the effect of these rodents on grasslands. Rich Reading, Director of Conservation Biology at the Denver Zoological Foundation, stated flatly that the Biological Survey's figures claiming that prairie dogs reduced grass by up to 75 percent, were "vastly in error" (Dold 1998). Studies by Dan Uresk, a Forest Service biologist, have concluded that prairie dogs eat only a small percentage of grass--from 4 to 7 percent (Dold 1998). James Detling of Colorado State University in Fort Collins has found that prairie dogs are natural fertilizers, whose incessant grass clipping increases the protein content and digestibility of grass (Long 1998).

Other studies have examined the claims of cattle ranchers against prairie dogs and have demonstrated again and again that these rodents actually improve forage quality for livestock and, by cropping the shortgrass prairie, stimulate it to grow, increasing the amount of grasses around the towns (Wuerthner 1996). The American Bison prospered in herds of 50 million, much of the species range lying within prairie dog towns of the short-grass prairies. Their major predator, the highly endangered Black-footed Ferret (*Mustela nigripes*), has been eliminated in the wild as a result of poisoning and shooting campaigns. At least 130 grassland species are associated with prairie dog towns (Godbey and Biggins 1994), and up to 170 vertebrate species have been seen in these towns.

Another complaint of cattlemen, that cattle fall into prairie dog burrows and break their legs, has also been refuted. Don Sharps, a wildlife consultant, asked an audience of 200 ranchers if any of them knew of a case of a horse or cow that had broken its leg in a prairie dog town, and no one said yes (Dold 1998). Such prejudices are passed down from generation to generation and fuel the persecution programs against these ecologically important rodents.

Slow-acting poisons, such as zinc phosphide, are used by many animal damage control programs. This chemical takes up to 12 hours to kill prairie dogs, who suffer extremely painful deaths (Wuerthner 1996). Another technique is the placement of gas cartridges in prairie dog burrows. These are ignited and burn the prairie dogs alive (Wuerthner 1996). On federal lands, these programs are conducted by the Wildlife Services unit of the Department of Agriculture at public expense. In the 1980s, more than $6 million was spent to eradicate 460,000 acres of dog towns on the Pine Ridge Indian Reservation in South Dakota (Line 1997). This was the largest remaining prairie dog town in the United States (Dold 1998) and the site of the only population of Black-footed Ferrets known to exist in the 1970s. In 1993, Animal Damage Control (now called fiWildlife Servicesfl) used, sold or distributed 220,000 fumitoxin tablets, 60,000 gas cartridges, and 21,000 pounds of zinc phosphate baits in the northern plains states to eradicate prairie dogs (Wuerthner 1996).

Studies about prairie dogs have revealed them to be surprisingly intelligent. They communicate in yips and chirps, some of which are warnings to other members of the town. A study by Professor Con Slobodchikoff of Northern Arizona University has revealed that prairie dogs™ calls convey specific information, such as what size a predator is, what type of animal, its speed of travel and level of threat (Dold 1998). Slobodchikoff created experiments in which two people walked through a prairie dog town that had experienced hunting; one carried a simulated rifle, while the other did not. The prairie dogs gave different calls for each person, and when the "hunter" returned in a few weeks without his rifle, they still gave the call for a man carrying a rifle (Dold 1998). Such communication goes far beyond what most people consider rodents to be capable of and shows their ability to react to a variety of threats, including the most serious one, human beings. Unfortunately, their warnings could not protect them from poison, shooting, and even bulldozing of their burrows.

Knowledge about the true role that prairie dogs play in grassland ecosystems has yet to reach most ranchers and others who have a hatred for these rodents that seems to reach no bounds. Many compare notes on how many prairie dogs they have killed, usually by high-powered bullets that cause them to disintegrate on contact (Long 1998). One group in eastern Colorado with 30 members calls themselves the Varmint Militia and kills prairie dogs as a sport. They recently spent two full days shooting prairie dogs until activity in the prairie dog town slowed (Long 1998). One militiaman bragged of having shot 20,000 prairie dogs and wants to retire from his exterminating business to shoot them full time (Long 1998). These shooters recount with glee the story of a recent protest. Some animal rights protesters tried to stop one of these hunts and chained themselves together, refusing to move; the Varmint Militia called the Kit Carson County sheriff, who placed them in jail for the weekend (Long 1998).

Although private shooting may be difficult to stop, many biologists and conservationists have recommended that all government poisoning and shooting on public land be halted and that subsidies be offered to ranchers who do not kill prairie dogs on their property (DeBlieu 1993). Unfortunately, no action has been taken in this direction.

Sport hunting of these rodents is encouraged by state game departments, and many towns organize hunts as a form of recreation. These hunts, which often involve the killing of hundreds of prairie dogs in a single afternoon, are taking a

high toll of these declining animals in many areas (Wuerthner 1996). A South Dakota organization, Varmint Hunters Association, brags that its 45,000 members do society a favor by killing prairie dogs. The vice president, Marc Minkin, told a reporter, "I'd like to be able to step out my back door in the morning and take a couple of shots before my morning coffee" (Dold 1998). The organized prairie dog shoots draw "hunters" from around the country; one hunt held in Nucla, Colorado, obliterated an entire town (Dold 1998). This hunt, which involves taking pot shots at prairie dogs emerging from their burrows, which they must do to feed, is totally unsportsmanlike--a virtual slaughter.

Even in national parks, poisoning takes place as a result of pressure from neighboring ranchers. In spite of abundant habitat in Theodore Roosevelt National Park, Badlands National Park, Wind Cave National Park and various national monuments in the Great Plains, only 6,000 acres of prairie dog towns have been protected (Wuerthner 1996). In most cases, park authorities have been threatened with lawsuits unless they poison prairie dogs. In South Dakota, home of Badlands National Park, a prime potential area for reintroduction of the endangered Black-footed Ferret, the state has declared prairie dogs to be noxious pests and mandates their control (Long 1998). At Devils Tower National Monument in Wyoming, the park rangers use rifles and poison to thin the ranks of its prairie dog colony (Long 1998).

Increasingly, development in the form of housing complexes, malls, highways and industrial centers, has gobbled up millions of acres of land in the West, much of it inhabited by prairie dogs. Some developers merely bulldoze the towns, while others pay to have a company use a giant vacuum cleaner that sucks prairie dogs out of the ground amid deafening noise similar to that of a jet airplane taking off. The proud inventor of this machine bragged that it was non-lethal, and the rodents could then be killed humanely or otherwise disposed of to allow development programs to proceed. In fact, most of the prairie dogs taken in this manner are killed or injured in the process (Dold 1998). The trauma involved for the prairie dogs must be extreme. Many of the prairie dogs removed from their burrows have been offered for sale as pets, advertised in eastern newspapers. Although loveable and cute, these animals are not suitable house pets because they are wild rodents who require extensive dirt to burrow in. They cannot adjust to the unnatural environment of a home. Unfortunately, this new invention has been given favorable publicity in the media. The majority of prairie dogs that survive this operation end up as pet food, according to CNN (December 15, 1996).

A more humane program involves the moving of prairie dogs to safer environments. A Colorado organization, Prairie Ecosystem Conservation Alliance, hoses prairie dog burrows with water and a biodegradable dish soap that creates frothy suds below ground. The suds irritate the eyes of the prairie dogs, who come to the surface where members of the Alliance are waiting to scoop them up and place them in carriers. They then truck them to a safe area, preferably one with empty burrows, and release them (Dold 1998). An even better solution is to save the towns, since the latter method will not save all the other animals inhabiting the burrows. The city of Boulder, Colorado, became the first town in the state to officially designate land to protect prairie dogs. In 1987 it set aside a preserve for prairie dogs, which now covers almost 5,000 acres (Dold 1998). Fort Collins, further north, began with a reserve of 268 acres and now has 1,700 acres (Dold 1998).

A Native American Gros Ventre tribesman, Mike Fox, has come full circle, from sponsoring prairie dog shoots on the Fort Belknap Indian Reservation in Montana to understanding their positive effect on grasslands by watching Bison graze near the towns on the "best grass around" (Long 1998). There are 400 American Bison on the reservation, and Fox, who manages the reservation's wildlife program, has sharply curtailed prairie dog shooting and accepted 23 Black-footed Ferrets to be reintroduced into the 500,000 acres of prairie on the reservation (Long 1998). He tells Indian ranchers, who still kill prairie dogs, that these animals were here before, and the ferret is not a new animal, but an old one returning (Long 1998).

All but 2 percent of original prairie dog populations are now gone, having been poisoned out to make way for livestock or agriculture. The majority of remaining towns are still unprotected, and the poisoning continues. Grasslands with prairie dogs support far higher densities of mammals, birds and other wildlife than those without them.

Several prairie dog species have been driven to near extinction. The Utah Prairie Dog (*Cynomys parvidens*), native to

south-central Utah, became endangered from these programs and the loss of habitat to livestock and agriculture. Listed on the US Endangered Species Act, this species has a restricted range in southwest Utah, and after poisoning programs, its population fell from an estimated 95,000 animals in 1920 to only 3,300 in 1972 (Nowak 1999). Through protection accorded by the US Endangered Species Act, Utah Prairie Dogs began to rebound, and by 1984, the species was downgraded from Endangered to Threatened on the US Endangered Species Act. Populations of prairie dogs fluctuate widely, and counts of Utah Prairie Dogs in the early 1990s ranged from 6,400 in the fall to 24,000 after they had pups in the spring (Nowak 1999). The species has recovered somewhat overall, mainly as a result of the Fish and Wildlife Service program of transplanting prairie dogs from private to public lands (Turbak 1993). Initially, many of the released prairie dogs failed to survive, and not until they began releasing males in the spring, who industriously spent the summer excavating burrows to accommodate other prairie dogs released in the fall, did transplants succeed (Turbak 1993). Utah Prairie Dogs hibernate each winter in compartments in the complex maze of their underground tunnels.

Although some Utah Prairie Dogs have been placed on public land, 60 percent of them still live on private land, where special US Endangered Species Act regulations allow farmers and ranchers to shoot or trap an annual quota of prairie dogs; a high of 6,000 were killed one year, and in 1992, 1,543 were killed (Turbak 1993). Education campaigns and tax incentives to protect prairie dog towns would be far preferable to quota systems.

Mexican Prairie Dogs (*Cynomys mexicanus*) of southern Coahuila and northern San Luis Potos, Mexico, have declined as their habitat has been converted to agriculture and grazing land for livestock, and many colonies were exterminated by poisoning. The largest remaining town covers only 4,400 hectares (Nowak 1999). The species is listed as Endangered by the US Endangered Species Act as well as by the *2000 IUCN Red List of Threatened Species*.

A third species, the Black-tailed Prairie Dog (*Cynomys ludovicianus*) has declined by 98 to 99 percent (Wuerthner 1996) in a range which once extended from Montana and southern Saskatchewan to northern Mexico (Nowak 1999). The Biodiversity Legal Foundation in Colorado filed a petition in October 1994 to list it as a Category 2 species under the US Endangered Species Act, a category just below Threatened. Although the Fish and Wildlife Service's own biologists supported this listing, the petition was denied after political pressure from ranchers (Wuerthner 1996).

Thus, at least three of North America's five species of prairie dogs are in grave danger of extinction, and the remaining two have declined precipitously. Their ecosystems are threatened as well, as are many of the species that depend on them. Although they are extremely photogenic and likeable, prairie dogs are not ecotourist attractions at present. With protection and more publicity, such as nature films and education programs, they could become so, and this would enhance their conservation.

Conservationists have proposed some huge reserves for prairie dogs that would link remnant populations in parts of the West, where much of the land is now under the control of the Bureau of Land Management of the Department of the Interior. The latter department favors cattle ranchers more than prairie dogs, but with outside pressure and publicity, such a plan might become reality. The Fish and Wildlife Service has had difficulty locating prairie dog towns that are protected from poison programs in which to reintroduce captive-bred Black-footed Ferrets.

For their long-term survival, prairie dogs need extremely large territories. At present, fragmented populations, which are often reduced to a few hundred animals widely separated from the nearest prairie dog town, have lost viability from lack of genetic interchange, and some scientists fear that their natural behavior may be altered by this isolation. These loveable animals need more friends to speak out on their behalf and demand that they be protected from poisoning, "sport" hunting and other persecutions, and that sanctuaries be established.

Economically, they may be worth far more alive than dead. The potential for using prairie dogs as a focal point for ecotourism is great. Tourists would be delighted by their behavior and fascinated to see the rich wildlife that inhabits their towns.

Trophy and Sport Hunting
During the late 19th and early 20th centuries, wealthy European and American big game hunters traveled to Asia, Africa and South America to "bag" large animals that they proudly displayed as stuffed animals and heads mounted on the walls of their homes. Maharajahs of India and British hunters took what Vincenz Ziswiler (1967), in his interesting book, *Extinct and Vanishing Animals*, describes as "a morbid pleasure in killing." Lord Ripon, an Englishman who died in 1923, was credited with killing 500,000 game birds and mammals--about 67 creatures for every shooting day of his life (McClung 1976).

One maharajah turned away from hunting and became a famous conservationist. Brajendra Singh, the last Maharajah of Bharatpur, hosted hundreds of hunts on his estate at the Keolada Ghana marsh 100 miles south of Delhi. A shoot organized by an English lord resulted in the killing of 4,323 ducks by 39 hunters in one day. In 1970, Brajendra Singh converted the duck shoot marsh into India's best known bird sanctuary. Singh died in 1995, having presided over the preservation of this vast marsh and its rare resident birds.

Trophy and Sport Hunting: Page 1
The most prestigious trophy for maharajahs and colonial hunters was the Tiger (*Panthera tigris*), largest of all cats. One maharajah shot at least 1,000 Tigers in his lifetime, while another complained that his total bag of Tigers was only 1,150 (McClung 1976). The number of Tigers killed by these two maharajahs equaled the entire population of these cats in India by the late 1960s. Tiger hunts were a royal pastime and employed hundreds of native "beaters," who drove the frightened cat toward a hunter who was perched safely atop an elephant.

Tigers require large territories. Even in the best habitats, their natural density is low. They probably once numbered 50,000 in India alone, however, when forests covered much of the country. Tigers were hunted to extinction on the Indonesian islands of Java and Bali, where each was a separate subspecies, and they have been hunted to endangered status on Sumatra. In the western portion of their range, the Anatolian or Caspian Tiger (*Panthera tigris virgata*) once ranged from Turkey eastward through the Caspian Sea region of Central Asia. Hunting eliminated these Tigers in Central Asia centuries ago, and only a few isolated populations remained in Turkey by 1900. The last individuals in Turkey were shot in 1972. This subspecies was driven to extinction by trophy hunting and persecution by livestock owners. By the 1960s, Indian Tigers were endangered, yet trophy hunting and killing by livestock herders for the fur trade continued. Indian President Indira Ghandi established a conservation program called Project Tiger in the 1970s, which set aside many reserves and accorded strong legal protection. When the species was beginning to increase in numbers, a trade in their body parts for Traditional Chinese Medicine reversed this recovery.

Today, fewer than 5,000 Tigers remain in the wild. At the present rate of killing--one Tiger per day--the species will become extinct in the wild within 30 years or less. Hunting of these magnificent cats intensified in the 1980s and has accelerated everywhere. They are killed by poison, traps and guns wherever they survive. Villagers and professional

hunters sell Tiger pelts, bones and other body parts in a network of smugglers that reaches from rural India, Bangladesh and Indochina to China, Japan and Taiwan. Tiger pelts are openly sold as trophies in many Asian countries, including Pakistan, Cambodia and Vietnam. They are displayed on shop walls, often with head attached. Some Tiger cubs are even part of this trade, killed and stuffed to be sold as tiny curios.

This magnificent cat will not survive long without legions of rangers guarding the remaining animals. Anti-poaching funding is inadequate in almost all its range. Indian parks and sanctuaries, many of them set aside for the Tiger, are understaffed, and dedicated wildlife wardens are underpaid and poorly equipped to combat poachers (Currey 1996). Some Indian park wardens have been bribed by poachers and watch as they skin dead Tigers (Breeden and Wright 1996). Elsewhere in the Tiger's range in Thailand, Cambodia and Burma, for example, few parks and protected areas have been set aside, and wildlife conservation has low priority.

The market for the pelts and stuffed trophies of these last Tigers among wealthy status-seekers in Asia and elsewhere has increased in recent years. One Taiwanese businessman profiled in a *National Geographic* article (Zich 1993) proudly displayed three stuffed Tigers which he had placed in his bedroom; one of the Tigers was standing on a Lion pelt with the head attached. He protested, "I worked so hard to make money. Now I spend it" (Zich 1993).

In spite of what appear to be overwhelming odds, new projects are attempting to turn the tide. Anti-poaching work in Siberia has helped arrest the steep decline of this critically endangered race of the Tiger in a joint United States-Russian program (Galster 1996). An international fund begun by Exxon Corporation, whose logo is a Tiger, has sponsored anti-poaching work and research throughout its range as well as education programs to persuade Asians not to purchase Tiger products. The US Congress appropriated several million dollars for anti-poaching campaigns, and organizations, such as the Wildlife Conservation Society based in New York City, have worked in Cambodia, Indonesia and other countries to survey and aid in conservation of the species. Scientists have cooperated in studies of the Tiger and aided governments in conservation programs, as described in the recent book, *Riding the Tiger. Tiger Conservation in Human-dominated Landscapes* (Seidensticker *et al*. 1999).

The Asiatic Cheetah (*Acinonyx jubatus venaticus*) once occurred throughout the Middle East as far as India. In the 16th century, the Indian emperor Akbar the Great kept more than 1,000 Cheetahs for hunting. Only one litter was produced by his Cheetahs, and the species died out in India and all of its Asian range except Iran, where fewer then 200 animals remain (Hunter 1998). It is classified as Critical, the most endangered category by the *2000 IUCN Red List of Threatened Species*. The Northwest African Cheetah (*Acinonys jubatus hecki*) is listed as Endangered by the IUCN. In reality, it is nearly extinct, with possible survival only in Algeria, Morocco and Niger, having disappeared from Egypt, Libya and Western Sahara. In the Saharan region, nomadic tribes, such as the Tuareg and Toubou, hunt Cheetah in desert areas of Mali, Niger and Chad, using saluki dogs (Hunter 1998). On occasion, Cheetah prey on young camels in the area, their natural prey having been eliminated. The tribes have such a hatred for Cheetah that they pursue them if they see their tracks, with or without proof of predation (Hunter 1998). Being followed for days in the extreme heat, the Cheetahs sometimes die from heat and stress even before the men and dogs reach them (Hunter 1998).

Trophy and Sport Hunting: Page 2

In the stark deserts of the Saudi Arabian Peninsula and the Mideast, wildlife is not abundant. Animals struggle just to survive in the harsh environment. A wild desert equine became a casualty of unrestricted hunting after World War I. The Syrian Wild Ass (*Equus hemionus hemippus*) was hunted to extinction for sport and meat. These wild asses had been hunted out of most of their original range by the 19th century, but in 1850, they were still seen commonly in large herds in the region once known as Mesopotamia, between the Tigris and Euphrates Rivers. Perfectly adapted to the searing desert heat and sparse vegetation, they ran from natural predators at great speed, and their sand-brown

coloration camouflaged them. After thousands of years of adaptation and survival, these delicately hued wild asses found themselves shot at by 20th century soldiers and other hunters. World War I troops and later, civilians in all-terrain vehicles, chased them at high speeds, killing entire herds of these equines for "sport." With no natural cover and unable to outrun jeeps, entire herds were slaughtered. The last known Syrian Wild Ass was shot in 1927 as it came down for water at the Al Ghams oasis in northern Arabia (Day 1981). The surviving populations of this species, the Asian Wild Ass (*Equus hemionus*), are listed as Endangered by the US Endangered Species Act.

After World War II, Arab sheikhs began hunting Arabian Oryx (*Oryx leucoryx*), Arabian Gazelles (*Gazella arabica*) and Arabian Ostrich (*Struthio camelus syriacus*) in all-terrain vehicles and trucks, mowing them down with repeating rifles, shotguns and even machine guns. These macabre and senseless hunts even involved the use of planes and helicopters for spotting. Sometimes animals were pursued until they dropped dead from exhaustion. In 1955, some 482 cars took part in a hunt during the course of a "royal goodwill tour" in northern Saudi Arabia, and every living animal seen was gunned down (McClung 1976). The Arabian Ostrich formerly ranged from Syria to the Arabian Peninsula, and it became a casualty of these forays. The last wild Ostrich was killed and eaten by Arabs near the Trans-Arab oil pipeline north of Bahrain between 1940 and 1945 (Greenway 1967).

The Arabian Oryx nearly followed the Ostrich into extinction when the last three individuals left in the wild were killed off in 1972 in southern Oman (IUCN 1978). This statuesque white antelope, with long, curved horns that arch over its back, once inhabited a wide range in the Middle East, from Syria and Israel to the Arabian Peninsula (Nowak 1999). It was saved from extinction by actions of the Fauna Preservation Society, headquartered in England, and the IUCN, which had undertaken an expedition in 1962 to capture some of the last wild Arabian Oryx for captive breeding. In eastern Aden, four oryx had been taken into captivity, and this herd was augmented from private game farms and zoos by another eight animals, which were transported to the Phoenix Zoo in Arizona. They adjusted easily to the desert climate of the American Southwest and soon bred in captivity. This herd has grown, and several zoos now breed them. Some of these stately animals have been reintroduced successfully into preserves in Oman and other parts of their original range. They have been studied by field biologists who have found that they reverted to wild behavior, with females in separate herds, and males solitary or in bachelor herds defending territories (Nowak 1999). Eighteen breeding herds occupied 14,121 square kilometers in Oman in two 1988 studies (Nowak 1999). In 1990, more Arabian Oryx were reintroduced into Saudi Arabia. There are now about 500 of these oryx in the wild and an additional 300 in captivity on the Arabian peninsula; 2,000 are held in zoos (Nowak 1999). For many Arab conservationists, the return of the Arabian Oryx has been an important event because this species has been very important to the cultures of the Arabian Peninsula for thousands of years. The reintroduced oryx have been guarded zealously to prevent another tragic disappearance.

Gazelles of dryland and open country were at one time abundant throughout North Africa and the Middle East, able to survive in the hottest and dryest of deserts. People have long hunted them for food, and there is little cover where they can hide. In ancient times, stone corrals were constructed into which gazelles were driven for slaughter, and until the early 20th century, these were still in use (Nowak 1999). Some Arab hunters still use captive and trained falcons to harass gazelles in order to frighten and confuse them so they can then be chased down by dogs (Nowak 1999). Two of these small and dainty ungulates have been hunted to extinction, and others have become very rare throughout the region. The Antelope Specialist Group of the IUCN lists the Saudi Gazelle (*Gazella saudiya*) as extinct in the wild and the Queen of Sheba's Gazelle (*Gazella bilkis*) of Saudi Arabia as extinct, with no captive populations. Until the 1990s, the latter species had been classified as Endangered. But the *2000 IUCN Red List of Threatened Species* reports that this delicate animal, which was considered very common in 1951, has not been seen in decades. A survey in 1992 in its range in mountains near Ta'izz failed to find any of these gazelles.

The *2000 IUCN Red List of Threatened Species* categorizes many other gazelles of the region as Threatened and Endangered. The Arabian Gazelle (*Gazella gazella*), native to the Arabian Peninsula, Israel and Palestine, is classified as Conservation Dependent, a category indicating that without strict protection it would decline to Threatened status. Five subspecies of this gazelle are listed in various categories, the most endangered being the Palestine Mountain Gazelle (*Gazella gazella gazella*) (Conservation Dependent) and the Acacia Gazelle (*Gazella gazella acaciae*)

(Critical) of Israel, and the Muscat Gazelle (*Gazella gazella muscatensis*) (Critical) of Oman. Another threatened gazelle is the Arabian Sand Gazelle (*Gazella subgutturosa marica*) (Vulnerable). These little Mideastern gazelles have been heavily persecuted and hunted. Added to the hunting, which is not well controlled, the Arabian Peninsula and much of Israel and Palestine have been heavily overgrazed by livestock, and the scarce oases are used for agriculture and livestock, leaving little natural vegetation for wildlife.

Reintroduced gazelles in Israel's Golan Heights increased to about 4,000 in the late 1980s, and government officials decided to allow the hunting of 2,000 of them by Arabs, who shot to wound rather than kill so that the animals could be killed ritually through throat slitting. This hunt, filmed by Afikim Productions and Survival Anglia in 1990, was a gruesome sight of crippled and dazed gazelles, stumbling about after the shooting.

The most avidly pursued animal by Arab sheikhs is undoubtedly the Houbara Bustard (*Chlamydotis undulata*). The meat of this large, long-legged bird of scrubby desert and sandy grasslands is considered an aphrodisiac by Arabs, although in fact it is a mild diuretic (Weaver 1992). It has been hunted relentlessly on the Arabian Peninsula, causing many populations to disappear. Arab sheikhs have hunted these birds for centuries using a trained falcon that catches the bird as it flies to escape. The great oil wealth accumulated by sheikhs of Saudi Arabia, Qatar, Bahrain, Kuwait and the United Arab Emirates has allowed them to indulge in this "sport" in a manner befitting the bejeweled and pampered rulers of ancient kingdoms. With these bustards so rare on the Arabian Peninsula, they now hunt them in Pakistan. Traditionally, the sheikhs used camels as transport, but today they drive in fleets of 60 or 70 customized all-terrain vehicles, careening through the desert at speeds up to 80 miles per hour, flattening the landscape, vegetation and small animals under their wheels (Weaver 1992). Armed with high-powered guns to shoot any animal that comes into view, the sheikh occupies an elevated seat that swivels 180 degrees to enable him to spot the Houbara Bustards and their tracks in the sand (Weaver 1992). The ecological damage done by the armies of vehicles that flatten vegetation, scar the landscape, and slaughter every animal they see is so severe that it may result in the local extinctions of many rare and delicate species of the Pakistani desert (Hoyo *et al*. 1996).

Many Houbara Bustards winter in Pakistan, converging from breeding areas in Kazakhstan and other countries in the region. Their breeding range extends to North Africa east across Asia to China. In Pakistan and 23 other countries, including India, Iran and Russia, the Houbara Bustard is totally protected from hunting (Weaver 1992). Yet by means of lavish gifts and payments to high government officials and landowners, wealthy Arabs have received special dispensation to pursue and kill thousands of these birds, which are considered endangered and declining in many parts of their range, especially in North Africa, Bahrain, Jordan, Iran, Iraq and India (Hoyo *et al*. 1996, BI 2000).

These extraordinary birds present a spectacular show with their elaborate courtship, strutting and displaying beautiful white puffs of head and body feathers.* Some hunting, mainly illegal, also occurs in their breeding grounds, which greatly disrupts their courtship, nesting and care of chicks.

*"Red Desert," a film in the series fiRealms of the Russian Bearfl described in the Video section, shows these birds displaying and hunting lizards.

The hunts have been carried on for decades in Pakistan, and Houbara Bustards have declined steadily as a result. As early as 1983, scientists and conservationists at a symposium on bustards convened by the International Council for Bird Preservation (now BirdLife International) unanimously called for a five-year ban on hunting (Weaver 1992). Although Pakistan's President at that time supported the symposium, he ignored the appeal and, the following year, allowed 25 parties from the Saudi Arabian Peninsula to hunt; they killed more than 5,000 Houbara Bustards (AWI 1985). Since that time, hunts have continued in spite of changes in administration in Pakistan, and although Arab hunters realize that these birds are heading toward extinction, they have not decreased their kills or practiced conservation. Moreover, they are now hunting in new areas, close to breeding grounds (BI 2000).

One sheikh, the cousin of the ruler of Dubai, found no Houbaras in the tract where he had arranged to hunt. He then moved his camp into Kirthar National Park, where he illegally killed more than 200 Houbaras in 10 days, along with

protected gazelles and ibex (Weaver 1992). As recently as the 1960s, Houbara Bustards were so numerous in Pakistan that they could be counted "like butterflies in a field," but by the 1990s, they became scarce in many areas, and their populations have experienced sharp downward trends (Weaver 1992). No restrictions are placed on the take of Houbaras by the visiting sheikhs.

Some Pakistani conservationists have fought the illegal arrangements made between the Arabs and government officials, and the Society for Conservation and Protection of the Environment (SCOPE), took the issue to the Sind High Court, which ruled in their favor (Weaver 1992). However, because Pakistani government officials rarely follow such provincial court decisions, the hunt did not end. When asked why the government has done so little to protect its wildlife, a well-known Pakistani environmentalist, Wahajuddin Ahmed Kermani, the retired Inspector General of Forests, replied, "Because we lack the moral fibre and the moral courage" (Weaver 1992).

Protests from conservationists in Europe and elsewhere have had no real effect either. Paul Goriup, the bustard expert at BirdLife International in Cambridge, United Kingdom, believes that populations of Houbara Bustards in Sind and Punjab provinces of Pakistan have become "terribly diminished," and hunting of breeding populations has a disastrous effect (Weaver 1992). Goriup contends that the species must be protected by the United Nations' Bonn Convention on Migratory Species to bring the issue to an international level (Weaver 1992). The Houbara Bustard is listed on Appendix I of CITES, which bans all commercial trade between member nations. Yet each year, 500 or more eggs, chicks and adult Houbaras are smuggled from Pakistan, a CITES member, by sheikhs who use them to train their falcons and for captive-breeding programs of dubious effectiveness. Abrar Mirza, the wildlife conservator for the Province of Sind, confiscates many such shipments, but most provincial wildlife officials merely look the other way, especially after receiving diamond-studded, gold Rolex watches and other such gifts from the Arabs (Weaver 1992). The confiscation of so many Appendix I birds in the United States would result in severe penalties, including possible jail sentences, but the effectiveness of CITES depends on the legislation each member country enacts to enforce it and the zeal with which these laws are enforced.

Sheikhs from the United Arab Emirates (UAE) were not so well-received in Turkmenistan in 1995 when they applied to the Ministry of Foreign Affairs to hunt Houbara Bustards. This Ministry forwarded the request to the Ministry of Nature Use which, quite unexpectedly, turned it down because the birds would be breeding (Zatoka 1995). Certain that they would be able to overcome this opposition, the sheikhs arrived in Turkmenistan ready to hunt without official approval, bringing their falcons (Zakota 1995). To their amazement, they were issued an official complaint by the Director of the Department for Animal Conservation and fined $40,000 (Zakota 1995). The sheikhs then turned to Turkmenistan's President Niyaziv, confident that they would be able to overturn the decisions of the wildlife department; instead, he backed up the decision of the Ministry of Nature Use, stating that it had jurisdiction in this issue (Zakota 1995). This was an extremely important precedent and a fine example of a country according its wildlife the respect and protection it deserves. Turkmenistan has a record of combating poaching and conducting environmental research and conservation programs (Zakota 1995).

One sheikh has renounced hunting and fostered environmental programs. Sheikh Zayed of the United Arab Emirates, while hunting gazelles with a rifle, realized that this amounted to "an outright attack on animals" and a cause for their possible extinction (Morgan 1998). He then began a program of setting tracts of land aside for wildlife and setting up breeding herds of endangered oryx, gazelles and other desert ungulates on an island off the coast (Morgan 1998). Other UAE sheikhs have obtained special favors when hunting on the African continent. The government of Tanzania granted exclusive hunting rights in one of the country's most important wildlife areas to a high-ranking official from UAE (Alexander 1993). The agreement was reached in secret with the Deputy Minister of Defense of that country, and he apparently has been allowed to hunt endangered species, such as Cheetah, with automatic weapons (Alexander 1993). The influence of wealthy Arabs in bending wildlife laws has reached to many corners of the world. One of their prime targets is North America for its beautiful Gyrfalcons (*Falco rusticolus*), listed on CITES Appendix I, one of the most coveted of all birds of prey for falconry. Their attempts at bribery, often successful, to obtain these protected birds from Canada resulted in the listing of this species on CITES to prevent any further commercialization of these birds, which was causing declines in their wild populations.

Trophy and Sport Hunting: Page 3
The vast Sahara has been the scene of similar hunts. Scimitar-horned Oryx (*Oryx dammah*) originally had a wide range in arid grasslands from Morocco and Senegal east to Egypt and the Sudan. In historic times, herds of 100 animals were commonly seen, and during wet season migrations, they traveled in groups of 1,000 animals or more. Their white and brown coloration allowed them to blend into the desert, and they were admired for their extremely long, back-curving horns. Their populations and range gradually shrank with hunting, overgrazing and agricultural encroachment on natural grasslands; the species disappeared from Egypt and Senegal in the 1850s. In the 1970s there were still an estimated 6,000 of these spectacular animals in the southern Sahara (Nowak 1999). The Haddad tribe of northern Chad centered their way of life around hunting these oryx, driving them into nets and killing them for their meat (Simon 1995).

Although traditional hunting made inroads into Scimitar-horned Oryx populations, the use of four-wheel-drive vehicles and modern firearms by prospectors and military personnel within the past 30 years drove the species to near extinction (Simon 1995). Groups of wealthy Middle Eastern hunters arrived with all-terrain vehicles and automatic rifles, eliminating these animals from most of their range. Chad's Ouadi Rime-Ouadi Achim Faunal Reserve became one of their only refuges by the 1970s, but the outbreak of war between that government's forces and Libyan-backed rebels in 1978 brought about an unregulated slaughter of the last population of Scimitar-horned Oryx within the reserve, reducing them to only a few hundred animals (Simon 1995). In an attempt to reintroduce these majestic antelope to their original range, 41 were captured in western Chad in 1966 and placed in captivity (Simon 1995). Some 500 of these oryx are part of the American Zoo Association's Species Survival Plan, and another 700 are in other zoos; an unknown number are in ranched herds, especially in Texas (Nowak 1999). A small number of Scimitar-horned Oryx were released into a national park in Tunisia in 1991 (Simon 1995), and others may be released in Niger (Nowak 1999). The IUCN listed this species as Critical in 1996, Extinct in Algeria, Egypt, Libya, Mauritania, Senegal, and Western Sahara, and Probably Extinct in Burkina Faso, Chad, Mali, Niger, and Sudan. The *2000 IUCN Red List of Threatened Species* listed the Scimitar-horned Oryx as Extinct in the wild.

The Addax (*Addax nasomaculatus*), a desert antelope which once ranged from Western Sahara and Mauritania to Egypt and Sudan, is now nearly extinct in the wild as a result of heavy hunting combined with loss of its grassland and shrubland habitat to agriculture and competition with livestock. Perfectly adapted to life in the desert, Addax are able to spend their lives without drinking water, deriving moisture from plants on which they feed (Nowak 1999). Instead of the long, arched horns of the Scimitar-horned Oryx, the Addax has horns that grow outward, then bend inward and upward. A stocky antelope that is not able to run quickly enough to flee men on horses, it has been easy prey for hunters and feral dogs. In recent years, remnant populations literally have been run to death by tourists in four-wheel-drive vehicles who pursue them until the animals fall dead in the sand (Nowak 1999). A herd in northeastern Niger was reduced to 50 to 200 animals when, according to some reports, they were wiped out by hunting. Fewer than 200 remained in north-central Chad, and another 50 along the border of Mali and eastern Mauritania in 1994 (Nowak 1999). The *1996 IUCN Red List of Threatened Animals* listed the Addax as Endangered, Extinct in Algeria, Egypt, Libya, and probably Sudan. The *2000 IUCN Red List of Threatened Species* upgraded its status to Critical. A small reintroduced population survives in Tunisia, but the wild population is at risk of disappearing altogether. More than 400 animals are in captivity, including a herd in a large dryland safari park in Texas called Fossil Rim.

Other Saharan animals have been ruthlessly pursued. Pelzeln's Gazelle (*Gazella dorcas pelzelni*) have been pushed to Vulnerable status by hunting. They are listed on the US Endangered Species Act. The Slender-horned Gazelle (*Gazella leptoceros*), native to North Africa, is now endangered throughout its range, according to the *2000 IUCN Red List of Threatened Species*. The hunting of these desert animals by men in all-terrain vehicles, some armed with

machine guns, reached such heights in the 1970s that they nearly became extinct, and their status has not improved in the intervening years. The endangered Dama Gazelle (*Gazella dama*), also a heavily hunted species, is extinct in Algeria, Libya, Mauritania, Morocco and Western Sahara; it has been reintroduced into Senegal, and populations are now confined to Chad, Mali, Niger and Sudan (Baillie and Groombridge 1996). Cuvier's Gazelle (*Gazella cuvieri*), another North African species, is also extinct in the Western Sahara and survives in endangered populations in Algeria, Morocco and Tunisia, according to the IUCN. In some cases, antelope and gazelles have been pursued by hunters in helicopters who shoot at them with rockets, a method also used to kill African Elephants in Chad, where the last Greater Kudus (*Tragelaphus strepsiceros*) were destroyed in 1976 (Anon. 1977).

Trophy and Sport Hunting: Page 4

Poachers have caused the extinction in Somalia of the endangered Hunter's Hartebeest or Hirola (*Damaliscus hunteri*), which now survives only in a restricted portion of scrubby desert of south-eastern Kenya. Looking somewhat like an Impala, this delicate, dryland antelope can live for weeks on very little water. This species is considered an evolutionary relic, having lived on earth for 15 million years, and is a progenitor of other hartebeests and the Topi; fossil evidence indicates that the Hirola's range once extended to South Africa (McKinley 1996). Kenyan populations totaled 14,000 in 1976, living along the Tana River and in the arid Garissa region to the east (McKinley 1996). In the 1980s, poachers killed off the region's African Elephants, who had kept the land clear of thorn bushes for grazers, such as the Hirola (McKinley 1996). A rinderpest epidemic brought in by cattle herders wiped out half the region's antelope between 1983 and 1985.

In the early 1990s, Somali refugees and troops fleeing from civil war in Somalia crossed into Kenya and began slaughtering the Hirola (McKinley 1996). By 1993, only 2,000 Hirola survived, and with unregulated hunting, a 1995 census found a total of 306 animals scattered in small groups over 45,000 square miles (McKinley 1996). Rangers from the Kenya Wildlife Service decided to capture and move as many as possible of the remaining animals to Tsavo National Park, where they could be guarded against illegal hunting. One hundred animals were moved to the park in 1995, and a year later, about 57 survived. In 1996, more were chased by helicopter into nets, sedated, blindfolded, and then taken by truck to a small plane which airlifted them to Tsavo. The habitat in Tsavo is lusher and greener than their native desert shrub, and the Hirola may not thrive there. Only time will tell. The *2000 IUCN Red List of Threatened Species* lists the species as Critical.

Trophy and Sport Hunting: Page 5

In South Africa, the Quagga (*Equus quagga*), a zebra-like equine, became extinct from hunting. Some zoologists consider these animals to have been a race of Burchell's Zebra (*Equus burchelli*), but others classify them as a full species. They had black, vertical stripes on the head and neck, while their back and haunches were uniform grayish or faintly striped. Native to the Cape Colony grassy plains, their limited and open habitat made them vulnerable to the Boer settlers, who killed them by the thousands (Day 1981). Many were tamed and used to guard domestic livestock at night because they gave loud alarm calls upon seeing predators (Day 1981). Some were even shipped to London and used as harness animals. The Boers used their skins for sacks and other practical purposes. By the 1850s, it had nearly disappeared from the Orange River area from relentless hunting (Nowak 1999). The last wild Quagga was killed in 1878, and in 1883, the last captive Quagga died in the Amsterdam Zoo (Day 1981). Photographs (Nowak 1999) and specimen skins exist with DNA that has been compared with living zebras. There has been talk of restoring a Quagga-like animal through selective breeding with Plains Zebras.

Many other South African species were reduced to endangered status or eliminated from the country altogether by

Boer hunting and their policy of clearing the land for livestock and agriculture. Although many parks have been set aside, wildlife as a whole has been crowded out of its natural environments in South Africa. Elephants became restricted to an area in the northeast that later became Kruger National Park, and only recently have they been reintroduced into a few parks elsewhere. Zebras have become extremely rare, with several races critically endangered (see Grasslands, Shrublands and Deserts chapter).

The high-altitude Simien Mountains National Park (6,234 to 14,535 feet) has many endangered endemics. A Survival Anglia film, fiEdge of the Abyss,fl records many of these species, including the Walia Ibex (*Capra walie*), a mountain goat found only in Ethiopia. It has a population of about 300 in the park and stays above 10,000 feet, browsing in the giant heath. These goats were common until the 1930s when hunting decimated their numbers. They also have lost habitat to agriculture and livestock. By the 1960s, there were only 200 Walia Ibex in the park, and although they have recovered somewhat, they still are poached for their magnificent, massive curved horns, hides and meat. Poachers enter the park and place nooses on the narrow mountain trails they must use to travel from one part of the park to another.

Trophy and Sport Hunting: Page 6

Local villagers in Kankani, India, have turned the tables on hunters of the threatened Blackbuck. This town, located in the Rajasthan desert of western India, has a history of preserving nature, refusing to allow an 18th century maharajah to cut their trees by encircling them and vowing to be killed rather than let the maharajah's men cut the trees (Bearak 1998). When hunters in all-terrain vehicles awoke the villagers with gunshots in October 1998, the villagers chased them off and got the license plate number of the driver (Bearak 1998). Some bucks of these striking black-and-white antelope had already been killed. "These animals are considered sacred to us, and we consider their lives more important than even our own," said a village elder of the Bishnoi people (Bearak 1998). The license turned out to belong to a famous movie actor, Salman Khan, star of many high-action, violent films (Bearak 1998). The story was told in many newspapers, and public opinion turned against Khan, who came to symbolize the callous rich who take pleasure in poaching endangered species like the Bengal Tiger and Sarus Crane (Bearak 1998). The week before, he had hunted Chinkara (*Gazella bennetti*), a Conservation Dependent species, according to the IUCN. On October 12, 1998, the actor was arrested, but he was unlikely to go to jail, as a result of his fame and wealth. The village elder said: "Between us and the animals there is complete trust. Our teachings tell us that we must serve as protectors and nurturers of all living things" (Bearak 1998).

Trophy Hunting Clubs

The US-based Boone and Crockett Club keeps records of trophy animals for North American mammals, and Safari Club International (SCI) maintains international records and promotes trophy hunting of animals worldwide. US state wildlife departments tend to favor sport hunting, and many earn large license fees from the trophy hunting of Bighorn Sheep, Elk, Grizzly Bear, Gray Wolf and other mammals. Trophy hunters in North America vie with one another to receive the "Outstanding Hunting Achievement" trophies awarded each year, primarily for having killed one each of 29 big game animals, some of which are on the US Endangered Species Act list (Williams 1991). Trophy hunting organizations have "master measurers" who check the size of horn, antlers and other measurements of animals killed for record books. SCI gives awards to those who kill at least 13 of the world's 22 species of "available" wild sheep (Williams 1991).

Rifles that fire at distant targets with telescopic lenses, elaborate blinds, heat sensors, and other technological gadgetry have weighted the contest so much in favor of the hunter that animals have become mere targets, with virtually no

hope of escape. Hunters using these high-powered rifles revel in recounting their experiences in hunting publications, whose writing fees help pay for their trips. One hunter's 1997 account recorded his delight in seeing the look of total shock of an Alaskan Dall Sheep (*Ovis dalli*) as it died from a shot he fired without it even having been aware of his presence. The hunter had selected the largest male with the most massive horns, which curved into a complete circle. Such hunting can so terrify animals that they run off cliff edges or flee into places from which they cannot escape.

Bernard Grzimek's *Animal Life Encyclopedia* recounts a hunt in the Canadian Rockies of Mountain Goats (*Oreamnos americanus*), in which five animals were pursued by hunters. They fled in terror, becoming entrapped on the ledge of an overhanging cliff, unable to move in any direction (Grzimek 1968). The hunters returned to their camp where they could see the goats as they stood on the ledge. The next day, the goats were still standing on the spot, but during the following days, they gradually became weakened and fell, one after another, usually at night, to their deaths. The last of the animals fell after 10 days (Grzimek 1968).

One US trophy hunter, Donald G. Cox, has hunted in 68 countries, taken 208 different species, including 125 from Africa, and has killed 23 of the world's spiral-horned antelope (Williams 1991). Trophy hunters try to kill as large a number of species as possible and as many trophy-sized animals as they can shoot. Many trophy hunting organizations claim to have made major contributions to conservation, but documentation is often lacking. SCI has published brochures in which it claims that it purchased habitat for endangered species. As it turned out, on investigation these claims were unsubstantiated (Williams 1991). Endangered animals are often the prime targets of trophy hunters. Safari Club International makes regular applications to the Fish and Wildlife Service to import trophies of endangered species. A 1978 application was particularly stunning because it requested permits to import 1,120 animals of a wide range of species, including Orangutans, various species of monkeys and crocodiles, and 39 species of endangered deer, gazelles, wild sheep, antelope, rhinoceroses, and 12 species of endangered wild cats. After a public outcry, the Safari Club withdrew its application, but in 1982, it was successful in its long battle to allow importation of Leopard trophies.

Trophy hunting clubs have made financial contributions to officials in foreign countries to receive permission to hunt endangered species and have convinced wildlife officials in countries such as Pakistan, Zimbabwe and Botswana that trophy hunting fees pay for conservation and should form the basis of wildlife management programs. The profits from trophy hunting pale beside those of ecotourism, however (see Trophy Hunting vs. Ecotourism Revenues section below).

Illegalities

Trophy hunting organizations have lobbied the US Department of the Interior for decades to weaken law enforcement "overzealousness" and have, on occasion, been successful. The Law Enforcement Division of the US Fish and Wildlife Service has tended to be strict in prosecuting trophy hunters for violations. In one case that inflamed Safari Club International members, it subpoenaed pages of the SCI™s *Record Book*, which listed many endangered species, to determine the details of the killing of various protected animals. To shield its members from prosecution, SCI returned information to their members on trophy animals killed at a time when they could not have been imported legally, and deleted this information in the SCI database to avoid further investigations (Williams 1991).

In another case, however, SCI influence won favors from the Department of the Interior. A highly placed official with the Fish and Wildlife Service, Richard Mitchell of the Office of Scientific Authority, allegedly accepted money from SCI in exchange for facilitating permits to get endangered species trophies into the United States (Williams 1991). Correspondence between Mitchell and SCI members included advice on registering as an institution with CITES on behalf of the trophy museum that the organization maintains in Arizona. Mitchell suggested that he would arrange to register several institutions in China and Pakistan in order to trade endangered species "specimens" with them

(Williams 1991). Another official, Assistant Secretary of the Interior G. Ray Arnett, who later co-founded a lobbying organization for trophy hunters, helped a fellow hunter caught importing an endangered species in the early 1980s by ordering agents to return the trophies to the smuggler, Thornton Snider (Williams 1991). Rick Parsons, who founded the Permit Office within the Fish and Wildlife Service, which gave permits to trophy hunters and others wishing to import endangered species, later became the Washington Counsel to Safari Club International, using his government experience to facilitate the permit process for trophy hunters and also lobbying at CITES Conferences on behalf of trophy hunters.

Ted Williams, in a 1991 article in *Audubon* magazine, tells of an appraiser for the Safari Club, R. Bruce Duncan, who arranged for many members of the club to mislabel the trophy animals they killed in foreign countries in order to import them into the United States without prosecution under the US Endangered Species Act (Williams 1991). One Club member imported a Jaguar (*Panthera onca*) pelt from Venezuela, labeled as a "goat hide" under Duncan's advice, and valued at $60; Duncan had appraised it at $11,000 (Williams 1991). Another SCI trophy hunter, Andrew Samuels, was the winner of the 1990 "Weatherby Award" given by a firearms company to the hunter who kills the greatest number of average, as well as record-sized, game animals throughout the entire world and whose character and sportsmanship are "beyond reproach" (Williams 1991). An undercover Fish and Wildlife Service Law Enforcement investigation revealed that Samuels had confided having illegally killed a Bighorn Sheep and numerous endangered foreign animals and smuggled them into the United States by falsifying shipping documents (Williams 1991). These included Jaguars, endangered wild Markhor goats (*Capra falconeri*), rare African antelope, Jentinck Duikers (*Cephalophus jentinki*), Ocelot (*Leopardus pardalis*), and a wild Asian sheep, the Punjab Urial (*Ovis orientalis punjabiensis*) (Williams 1991). Samuels paid $100,000 in fines, spent 30 days in jail, and performed 800 hours of community service; he also forfeited his world hunting rights for three years (Williams 1991).

In another case, John Funderburg, the curator of the North Carolina Museum of Natural Sciences in Raleigh, acquired more than 1,800 animals as "specimens," many of them endangered, that had been killed by trophy-hunting acquaintances (Williams 1991). They were donated to the museum as tax-exempt, but had little scientific value because they lacked information about the location or date where they were killed, and many were merely heads mounted for hanging on walls. Scientific specimens consist of the skins of entire animals, or their skeletons. A number of the donated trophy animals mysteriously disappeared from the collection, apparently returned to the donors (Williams 1991). In exchange for financial "donations" to the museum, the trophy hunters received the title of "associate curator," with certificates that allowed them to misrepresent themselves to foreign wildlife officials in order to obtain permits to kill protected animals (Williams 1991). Funderburg urged the hunters to send him the trophy animals via private taxidermists to avoid the attention of authorities, but a five-year undercover investigation by Fish and Wildlife Service Law Enforcement revealed all the details of this scam (Williams 1991).

The highly respected Smithsonian Institution has not been invulnerable to such unprincipled arrangements. A wealthy real estate developer, Kenneth Behring, pledged $20 million to the Institution's National Museum of Natural History in 1999, the largest donation in the 151-year history of the museum (Golden 1999). Behring, a trophy hunter and past president of Safari Club International, donated the remains of four endangered Central Asian wild sheep, including the Kara-Tau Argali (*Ovis ammon nigrimontana*) of Kazakhstan, listed as Critical by the *2000 IUCN Red List of Threatened Species*, to the museum. This animal cannot be imported legally because it is listed on the US Endangered Species Act, but on behalf of Behring, the Smithsonian petitioned the Department of the Interior to waive the ban in order to have the trophy shipped into their collection (Golden 1999). This action set an unfortunate precedent for this august institution. Behring is also under investigation for illegally killing three bull elephants in Mozambique, in spite of a $20,000 "donation" he made to a local hospital in the province (Golden 1999). The head of Mozambique's wildlife department, Arlito Cuco, said that the hunt was illegal, "Because according to the law in Mozambique, you cannot hunt for sport" (Golden 1999).

Hunting magazines often glorify the pursuit of endangered species. An article in *Sports Afield* encouraged the hunting in Mexico of Jaguar, Ocelot, and "crested Guan," or Horned Guan (*Oreophasis derbianus*), a highly endangered pheasant-like bird (Anon. 1981). It noted parenthetically, "However, United States laws prohibit bringing in skins"

(Anon. 1981).

Effects of Trophy Hunting on Animals

Among the most coveted of the "Grand Slam," or the most prestigious trophy animals, is the Brown Bear. The Kodiak Bear (*Ursus arctos middendorffi*) of Alaska represents a major trophy for hunters who come from all around the world to kill large males. This bear exceeds other subspecies in size, weight and skull size. These bears have been isolated since the end of the last Ice Age, and the abundant food supply of salmon runs, berry bushes and other edible plants in their habitat has produced this giant bear (Chadwick 1990). Trophy hunters pay $20,000 or more to private hunting guides for the privilege of shooting these bears. A recent study has revealed a potentially disastrous effect on the species of this trophy hunting. According to *The Kingdom. Wildlife in North America*, by the respected author and National Geographic Society correspondent Douglas Chadwick, "Continued harvesting of the biggest animals by trophy hunters has caused a decline in the average size of Kodiak Bears over the years" (Chadwick 1990). Thus, this record-size animal is gradually becoming smaller and smaller as a result of trophy hunting.

The pressure of hunters on some populations of Alaskan bears is so intense that it has altered the behavior of males, preventing their normal feeding on salmon runs. On Admiralty Island in southeastern Alaska, part of the Tongass National Forest, tourists watch female Brown Bears fishing with their cubs, but rarely see males because they have become so wary of people after years of being hunted; even females without cubs can be hunted on Admiralty Island (Crittenden 1997). The rich salmon rivers on this island are among the world's most productive, and since clearcutting of timber has been banned, salmon thrive in the clear water. Salmon is an important portion of the diet of male bears, yielding a great deal of protein and helping to fatten them for the winter. By frightening the male bears from the salmon rivers, which they have fished for thousands of years, humans may be affecting the health, survivability and size of these bears. Each year more than 40 Brown Bears are killed on Admiralty, and hunters are lobbying to reopen hunting in areas such as Pack Creek that are now closed to protect the fishing spots (Hanson 1998). This island deserves to be declared a National Park, which would protect these bears from hunting.

Another effect of hunting male bears has recently been documented by Swedish and Norwegian biologists, who found that in areas where resident adult male Brown Bears had been killed to thin the population, bear cubs suffered very high mortality for several years until dominant males reoccupied the territory (O'Neil 1997). Male bears, who have traditionally been considered threats to cubs, may be a danger only to cubs they have not fathered. Thus, the killing of bears by sport and trophy hunters may also result in the deaths of hundreds of bear cubs.

Russian Brown Bears have been hunted heavily in recent years. When a prominent government official, Prime Minister Viktor S. Chernomyrdin, announced early in 1997 that he wanted to trophy hunt a Brown Bear, local guides bulldozed a path to the den of a sleeping female bear (Filipov 1997). Tractors plowed a campsite for a large tent with mobile kitchen and cafeteria, and the Prime Minister flew in by helicopter (Filipov 1997). Chernomyrdin, accompanied by 12 hunters, rode a skimobile to the site, roused the bear and killed her two cubs and the mother. This incident received much adverse publicity in Russia. When the Prime Minister was criticized for his lack of sportsmanship, he replied: "What's wrong with that? Hunting of bears is not banned; it's a normal thing . . . I'd like to watch those who are writing about this meet those bears eye to eye to see their reaction" (Filipov 1997).

In Greece and Turkey, where Brown Bears are avidly hunted in spite of their dwindling numbers, cubs orphaned when their mothers are killed are often sold to zoos or to gypsies who treat them abusively. This trade is illegal in both countries, and the World Society for the Protection of Animals (WSPA) has saved many of these gypsy bears, who are dragged through the streets with nose rings and made to perform tricks. WSPA has placed several hundred of these abused bears in large wooded compounds, unfettered for the first time in their lives. Some had to be euthanized because of severe infections that had caused them extreme pain and serious physical disabilities that they had endured

for many years without veterinary treatment. The majority suffered the effects of malnutrition.

The animals trophy hunters seek--the finest specimens--are the very ones that should be left in the wild to maintain the species. Killing the largest specimens of a species, subspecies or population is likely to diminish it in size and survivability. This would seem elementary, but trophy hunters, state game departments, many in the Fish and Wildlife Service, the World Wildlife Fund and other organizations in favor of trophy hunting do not discuss or acknowledge this fact. Claims are made on behalf of trophy hunters that only old and non-breeding adults are killed, but this contention has been proven wrong in case after case. Brown and Grizzly Bears continue to breed until an advanced age. Other trophy animals have also been shown to be at their prime when shot.

Lions are a prime target of trophy hunters, who select the largest male specimens, especially those with enormous manes. Two filmmakers, Derek and Beverly Joubert, in producing their dramatic series, fiLions of Darknessfl for the National Geographic Society, followed three exceptionally large males for a long period. These magnificent Lions spent most of their lives in a national park in Botswana, but made the fatal mistake of leaving the park and entering a wildlife management area where trophy hunting was allowed. All were shot within a short time at the prime of their lives by trophy hunters.

Trophy hunting took a tragic and highly controversial turn when the government of Tanzania sold trophy hunting rights for African Elephants at more than $4,000 per animal in the early 1990s. The *2000 IUCN Red List of Threatened Species* classifies this species as Endangered. The government claimed that the largest animals, which for trophy hunters were the most desirable, were not active breeding males, but past the breeding age and, therefore, "excess." Tanzania issued 50 permits a year for trophy-hunted elephants (Brody 1994). At least four very tame bull elephants that had been studied for decades in Amboseli National Park in southern Kenya by biologist Cynthia Moss, author of two classic books, *Echo of the Elephants* and *Elephant Memories*, wandered into Tanzania in 1994, where they were shot at point-blank range by trophy hunters (Moss 1995). The hunters had received CITES permits from the Tanzanian government to export the tusks as hunting trophies (Moss 1995). Northern Hunting Enterprises, which organized the Tanzanian elephant hunt, is run by Rick Trappe, a German Tanzanian; the hunters were two Germans and an American (Brody 1994). One of the bulls killed, called "R.B.G.," was 47 years old at the time of his death, based on aging of the jaw--not old in elephant years--and so habituated to vehicles that he could be easily approached to within a few feet (Moss 1995). Cynthia Moss said she was "devastated" by the loss of the animals, who had come to trust researchers, tourists and rangers. She stated: "The message they got from us was, 'It's OK, we're not going to hurt you, you can trust us.' Then one day they walk two kilometers into Tanzania, where they'd been going for most of their lives, and they're blown away . . . I feel as if was lying to them" (Brody 1994). A spokesperson for the African Wildlife Foundation said: "The ethics of shooting these virtually tame animals is appalling. You can't call this a hunt of any kind" (Brody 1994). Had R.B.G. not been shot, he would have lived another 18 years, according to Moss (Brody 1994).

These were among a relatively small number of large, old bull elephants left in East Africa, protected through the ivory slaughters of the 1980s by the presence of field researchers and tourists. The assertion that they were non-breeding males was refuted by Moss, who had documented that they were active breeders and, in fact, among the top breeding bulls in the Amboseli population (Brody 1994). This disputes the view that they were not contributing to the gene pool and were "excess," worthy only of being used as targets. After protests and adverse publicity on television programs that reached the United States and elsewhere, Tanzania announced a ban on trophy hunting of elephants near the Tanzania/Kenya border on December 13, 1994, and initiated an investigation into the granting of permits to shoot the Amboseli bull elephants.

In spite of the supposed ban, two other big bulls of the Amboseli, Sleepy and Beach Ball, both in their 50s, were killed in Tanzania by trophy hunters in 1996. Both had fathered calves that were born after their deaths. The largest bull in Cynthia Moss's study area is the gigantic Dionysus who, at 55 years old, weighs some 6,000 kilograms, with 100-pound tusks. He probably owes his life to Cynthia Moss and other researchers who have deterred poachers, but should he wander into Tanzania, he may be killed. The females in the family, headed by Echo, an old matriarch, prefer

Dionysus above all the males, and he has fathered many calves. In a BBC film about her work in Africa, fiEcho of the Elephants. The Next Generationfl (PBS--WNET 1996), Moss pledged that she would spend the rest of her life watching over these elephants.

Another effect of trophy hunting of elephants and many other animals is an imbalance that is created between the sexes. The largest elephant bulls of both the African and Asian species have been killed off, leaving far too few males for the number of adult females. In some parts of Africa where the ivory massacres were the most intense during the 1970s and 1980s, virtually no adult males remained prior to the 1989 CITES ban on ivory. In Asia, adult male Asian Elephants (*Elephas maximus*), also listed as an Endangered species by IUCN, have become extremely rare because they were killed by ivory poachers. Females do not have tusks, and most have been spared by ivory hunters. In parts of Asia, males without tusks, a recessive trait, have come to dominate some populations, since they are not valuable for their ivory. This is altering the traits of the species.

After the largest bull African Elephants were killed off, trophy and ivory hunters turned to the older females, who have large tusks. They are essential in maintaining and leading family groups, providing experience, protection and guidance (Moss 1995). These older females, or matriarchs, have accumulated survival lore over many decades, acquired from previous matriarchs and their long life experiences. They also know the location of scarce water holes in the dry season, where to find minerals in clay they need for their nutrition, what plants are poisonous and other bits of survival lore that can mean the difference between life and death of herd members. Yet these matriarchs also were killed in the 1980s, leaving young, traumatized teen-aged females, who wandered in disarray, without the knowledge or authority of the older females. Females as young as 10 years old found themselves matriarchs of bands of orphan calves, many just weaned. Without direction, they often blundered, placing the calves at risk.

Scientists studying elephants over the past 30 years have documented hundreds of cases of trauma and apparent mourning when family members were killed. The elephants that suffer the most are the young who see their mothers and relatives butchered in front of them. Researchers in the 1990s have noted that many of these young elephants fail to develop normally and are extremely shy, unable to find food and cope with predators as effectively as adults. Some young males, who were calves when they watched as their families were slaughtered by poachers or in culls in South Africa, were released in national parks where they later became unruly and destructive to property and to other animals. Only when older elephants were released to lead and discipline them did they calm down and assume the peaceful personality that characterizes the species.

Zimbabwe, Botswana and Namibia submitted proposals in 1997 to the CITES Conference that the African Elephant's population in their countries be down listed from CITES Appendix I to Appendix II to allow export of trophy-killed elephants. Zimbabwe requested commercial trade in trophies, and Namibia, non-commercial trade. This proposal was amended to read "for non-commercial purposes" and adopted by the CITES members at the 1997 Conference. This is a step in the wrong direction, as hunters will arrive in these countries from around the world to kill the largest, prime elephants as trophies. Shooting elephants in open country where they have no cover is hardly sport, yet the hunting companies tout their massacre as a feat of bravery. Killing them as they come to drink at the few water holes that remain in the dry season in southern Africa is also unsportsmanlike. Matupula Hunters of Texas calls such hunting "exciting and rewarding." Their brochure states, "With the country dry and surface water limited, the elephant bulls can be tracked going to and from water, or in amongst the woodlands and forest where they feed and lay up" (Scully 1997).

Trophy Hunting vs. Ecotourism Revenues

The irony of the slaughter of elephants and other large mammals for trophies is that the funds accrued from trophy hunting or ivory are miniscule in comparison to the value of these animals as ecotourist drawing cards. In Kenya, a

1989 analysis on the viewing value of elephants found that between $25 and $30 million per year was earned in tourist dollars from people attracted to the elephants alone (Brody 1994). A new project provides a local Maasai tribe with about $23,000 a year from tour operators who camp there primarily to show visitors the big bull elephants that are now so rare in East Africa (Brody 1994). During the long life of an African Elephant, it may produce tourist revenue worth $1 million, distributed to a wide range of recipients, from airlines to travel companies, and to local economies (Currey and Moore 1994). By contrast, a trophy-hunted elephant brings a one-time fee of $4,000 to $20,000. Estimates for African Lions are similar. A fully maned male Lion, according to Lee Durrell (1986) in *State of the Ark*, is worth $500,000 as a tourist attraction, whereas a Lion shot for sport or trophy is worth between $3,500 and $8,500, and its skin about $1,000.

Ecotourism has shown an astronomic rise within the past decade, with magazines, books and films aimed at the ecotourist and soaring revenues accruing to countries that protect their natural heritage. Most tourists prefer to come to a country where the animals are tame and where senseless killing is not carried out. Countries that allow hunting of the largest specimens of their wildlife, whether elephants or Leopards, are likely to suffer loss of tourist revenue because they have fewer larger animals and the hunted species often become either shy, hiding from tourists, or belligerent, charging them. A recent article in *Africa. Environment and Wildlife*, a magazine affiliated with World Wildlife Fund South Africa, gave advice to tourists coming to Okavango. Daryl and Sharna Balfour (1998) recommended that tourists avoid coming during hunting season, which runs from early April to mid-September, because game is "scarce in this areas, skittish and almost impossible to approach." They further noted that the sound of gunfire and the sight of carcass-laden vehicles can be disconcerting (Balfour and Balfour 1998). Wildlife can remain shy throughout the year, especially sensitive, gun-shy animals like elephants, and even beyond the suffering caused to the animals, this trophy hunting potentially deprives the country of far greater revenues that tourists could contribute. Several tourists have been killed recently by charging African Elephants in areas where the animals had been trophy hunted.

Tourists coming to South Africa have increased in number in recent years, producing revenues totaling $6 billion in 1995; a large percentage of this total derives from tourists coming to see scenery and wildlife. By contrast only $2 million in trophy hunting fees for rhinos, and a few million dollars more for other animals, were earned in that year, according to the Natal Parks Board (Hughes and Brooks 1996).

Botswana earns $100 million per year from tourism and only a tiny fraction from trophy hunting, yet the government actively promotes the latter activity and has failed to give national park status to its crowning jewel, the Okavango Delta. Portions of this superb wildlife area have been designated as game reserves which allow hunting, but most remains unprotected (Balfour and Balfour 1998). By contrast, Kenya has designated vast areas as national parks and has encouraged ecotourism for decades, with the result that the government earned $500 million in 1996, up from $452 million in 1995. A new organization, Okavango Peoples' Wildlife Trust, in Botswana, is pressing for a complete ban on trophy hunting in the immense Okavango Delta wetland (Jackman 1997). As a result of livestock fencing in the area, African Buffalo are declining 18 percent a year, and Lion, zebra, Sable Antelope and waterbucks are also becoming scarce (Jackman 1997). This organization has proposed that all hunting, except for subsistence or problem animals, be banned and that the Delta be promoted as an ecotourism center, with low-impact camps for luxury visitors (Jackman 1997). New fencing has blocked about one-fourth of the Okavango to wildlife, who migrate to this oasis from surrounding desert areas as a vital refuge for many months during the year. These fences also have blocked wildlife migrations between Namibia and Angola, a disastrous event for many thousands of animals (Jackman 1997). This region has enormous potential for ecotourism that would far outweigh the revenues from cattle ranching or trophy hunting.

In general, funds from trophy hunting end up in government coffers and in the pockets of a few tour operators; the people of a country receive little of the revenues. By contrast, ecotourism funds are spread throughout the local economies, with hotels, taxis, buses, restaurants, souvenir shops and others benefiting from the greater number of tourists than hunters. In fact, the number of trophy hunters is miniscule in comparison to the number of ecotourists. In most countries, hunters amount to a few hundred or thousand, versus hundreds of thousands--or even millions--of

tourists. In some countries, a portion of trophy fees and the meat from slaughtered animals are shared with local villagers, but if they were given the same share of tourist money, it could be very profitable. This trend of sharing tourist revenues or park fees with local people is making an enormous difference in the lives of people around the world.

Meat Hunting

Three Asian wild cattle are endangered from hunting, and one of these is on the verge of extinction. The Kouprey (*Bos sauveli*), discovered in 1937, is classified as Critical by the *2000 IUCN Red List of Threatened Species*. Native to open lowland forests of Southeast Asia in Cambodia, Laos, Thailand and Vietnam, it is the size of a steer. Adult males weigh up to 1,980 pounds and stand 6 feet tall at the shoulder (Nowak 1999). Originally, the Kouprey's habitat consisted of low, rolling hills interrupted by patches of forest; it grazed in herds of up to 20 animals, covering some 15 kilometers a day in the open areas and entering the forest for shelter from the sun and refuge from predators (Nowak 1999).

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Meat Hunting: Page 1

Today, much of the Kouprey's habitat has become a battleground for bands of guerrillas who have planted land mines throughout the region and hunt and snare wildlife for food. After the Vietnam War and the Khmer Rouge occupation of Cambodia, Kouprey were only seen rarely (Stewart-Cox 1995). A 1986 survey found fragmented, small populations remaining in most of its range (Nowak 1999). A few Kouprey were seen in the 1980s trying to migrate through the steep escarpment separating Cambodia and northeast Thailand, but they apparently died in booby-traps set for people (McNeely and Sochaczewski 1988). The skull and horns of a female Kouprey were offered for sale in a shop in Poipet, Cambodia, in 1994 for $400, according to biologists surveying illegal trade in the country (Martin and Phipps 1996). The Kouprey has little chance of surviving without protection from hunting unless a large sanctuary is set aside for it. No strong conservation measures have been taken to date. No Koupreys are in zoos. It is possible that this species is already extinct.

The Banteng (*Bos javanicus*) is similar in size to the Kouprey, with upturned horns and an extremely stocky build. Brown to bluish-black, Bantengs have white legs and a white rump patch. Their range is larger than that of the Kouprey, extending from India to Myanmar (Burma), Thailand and Indochina, south through the Malay Peninsula to Java and Borneo. These animals are being crowded out of their forest and shrubland habitat by settlements and logging, and they are extremely vulnerable to hunting. They have become wary and shy, and large herds are now rare. Banteng have been domesticated in Indonesia and bred with domestic cattle, producing fertile offspring (Nowak 1999). Wild, genetically pure Bantengs are extinct in Bangladesh, Brunei, and probably India as well, according to the *1996 IUCN Red List of Threatened Animals*. The 2000 version of this list also classifies the species as Endangered.

The Gaur (*Bos gaurus*), largest of the three Asian wild cattle, is the most numerous, yet it is listed as Vulnerable by the *2000 IUCN Red List of Threatened Species*. Ranging from Nepal and India to the Malay Peninsula, these massive animals weigh up to 1,000 kilograms (2,200 pounds) (Nowak 1999). They have become extremely rare to absent in all

but protected national parks, and their populations have been estimated as extremely low, only about 1,000 animals (Nowak 1999). These animals are killed whenever possible for their meat throughout their range.

The Annamite Mountains extend along the border between Laos and Vietnam, rising to more than 6,000 feet in some areas, where stands of wet evergreen broadleaf forest harbor some of the strangest and rarest mammals on earth. Not until the 1990s were these remote forests explored by scientists, who examined skins and horns of rare animals killed by Hmong tribespeople. First to come to light in 1992 was the extraordinary Sao la or Vu Quang Ox (*Pseudoryx nghetinhensis*), a beautiful, gray, goat-like antelope. Its genus, *Pseudoryx*, meaning false oryx, indicates its superficial resemblance to oryx because of its long, straight, backward pointing horns. Weighing up to 200 pounds and 35 inches tall, this relatively large animal somehow had escaped the attention of scientists. (See photo in Nowak 1999.) Soon after discovery of several pairs of its horns, rewards were offered for live specimens. Two young calves were captured in Vietnam and placed in the Hanoi Zoo; within weeks, both were dead (Rabinowitz and Schaller 1994). Others were captured by villagers hoping to receive rewards, and some of the animals died (Nowak 1999).

The Hmong people know the Sao la well and hunt them whenever they can. They believe these antelope number at most a few hundred animals (Rabinowitz 1997). Many have been killed since their discovery, and hunters indicate that it has disappeared from some areas (Nowak 1999). Only a few hundred Sao las are thought to exist in Vietnam and Laos, where heavy hunting presents a major threat to them in spite of official protection by the Vietnamese and Laotian governments (Nowak 1999). Wildlife Conservation Society biologist Alan Rabinowitz (1997) estimates that they are restricted to an 800-square-mile portion of the rugged mountain forests along the border. In 1994, soon after this animal was given its scientific name, it was listed on Appendix I of CITES to prevent international commercial trade. The *2000 IUCN Red List of Threatened Species* lists it as Endangered. Vietnam set aside the Vu Quang Nature Reserve for these very rare animals and prohibited snaring in the reserve (Rabinowitz and Schaller 1994).

Other rare and newly discovered or rediscovered animals of the Annamite Mountains include two species of muntjac, or barking deer, one of which is the largest of all muntjac species; a long-snouted, yellowish wild hog rediscovered from a skull fragment; a striped rabbit, based on fur pelts found in a local village, which may be the same species or related to the endangered Sumatra Short-eared Rabbit (*Nesolagus netscheri*); and a very endangered palm civet (Rabinowitz 1997). The muntjacs and palm civet were discovered as captive animals, but nothing is known of the others, and searches for the wild hog have been unsuccessful (Rabinowitz 1997). Had these intriguing and unusual animals been discovered in a wilderness area in North America, they would be the subjects of field surveys and strict protection, as well as extensive media coverage. In Asia, where diversity is far greater and conservation a luxury few can afford, even such fascinating species may fade into extinction for lack of funding for conservation programs.

Throughout the region, much of the larger wildlife, from deer to large predators, has been hunted out, and guerrilla warfare has left the land marked with bomb craters and land mines. Alan Rabinowitz (1997), who has lived in Southeast Asia and witnessed overhunting in many countries, says, "The killing of wildlife in Laos was unlike anything I had seen elsewhere." Even within the Nakai Nam Theun Reserve, "walls of death" were constructed of thatch, bamboo and small trees, with openings rigged with snares; animals walking along the wall would be caught when trying to pass through an opening, snared by a leg or the neck, to "die a slow death" (Rabinowitz 1997).

Meat Hunting: Page 2

A wildlife slaughter of enormous proportions is taking place in Central and West African countries. Rural people who once killed animals only for personal consumption now hunt professionally, and markets in villages and cities now sell thousands of monkeys, antelope, wild cats, pangolins and even endangered apes (Pearce 1995, McRae 1997). Hunters use wire snares and leghold traps, high-powered rifles and dogs to track down animals. The tropical rainforests of west-central Africa, which once teemed with wildlife and echoed with their calls, are now falling silent.

For miles surrounding villages, wildlife has largely disappeared as local peoples throughout this vast region are killing every animal to sell its meat and body parts. Professional hunters have taken so much wildlife that little is left for local tribes. Logging corporations based in Europe have launched this commercialization of bushmeat by opening up previously impenetrable wilderness areas with logging roads and offering to buy animals that local people kill. Both the forests and the wildlife are being devastated.

Logging companies have taken advantage of these impoverished countries' national debts, buying rights to clearcut the majority of the remaining primary tropical rainforest in West and central-west Africa at bargain prices. The last primary forests in Cameroon, the Congo, the Democratic Republic of Congo and the Central African Republic are being cut and bulldozed, and their wildlife exterminated. Five-hundred-year-old trees with massive trunks 20 feet around, standing more than 100 feet tall, fall daily. The old-growth forests that provide homes for a myriad of wildlife will soon be gone at the present rate of cutting. In some areas, the logging is selective for certain species of trees, but this reduces forest diversity, and hundreds of trees are destroyed in the process of obtaining a few. When great trees fall, they bring down others, and logging roads and entry roads into forest tracts take thousands more trees.

In a shocking and moving report, *Slaughter of the Apes. How the Tropical Timber Industry is Devouring Africa's Great Apes* (Pearce 1995), the World Society for the Protection of Animals documents the tragic and gruesome slaughter of hundreds of Gorillas, Chimpanzees and other wild animals in Central African countries in this trade. The commercialization of wildlife and environmental devastation that have resulted are activities totally antithetical to the legislation and conservation ethics of the European countries--France, Germany, Italy, the Netherlands, Belgium and Denmark--that are sponsoring the logging (Pearce 1995). Several documentary films shown on the National Geographic Explorer program and CNN have shown the markets with thousands of small antelope, Chimpanzees, Gorillas, monkeys and other mammals lying dead on tables, offered for sale. fiAfrica Extremefl and fiNdoki Adventurefl are National Geographic films shown in March 2001 that document the discovery of poachers' camps with dead forest antelope, Leopard skins and other wildlife. One incident of snaring was filmed. A hunter filmed in the remote Ndoki Forest of the former Zaire found a Forest Pig struggling in a wire snare. The hunter began hitting the pig in the head to cause death, while the animal screamed and kicked. Only after hitting the animal about six times did death finally occur. Local hunters interviewed by the photographers said they regularly killed Bongos (*Boocercus euryceros*), rare and extremely beautiful rainforest antelope that are closely related to giraffes. These films traced the 1,500-mile voyage by Wildlife Conservation Society biologist Michael Fay through the last rainforests of the Democratic Republic of Congo and Gabon to publicize the fact that these magnificent wildernesses are being logged and their wildlife killed, and urgent action is needed to stop these activities.

Hundreds of Lowland Gorillas are being killed for the meat trade and sold for $40 per animal. Loggers place orders for Gorilla meat, which encourages the snaring and shooting of virtually every Gorilla that local people are able to procure for this grisly trade. WSPA found that in one district of the Cameroon, 800 Gorillas a year were being killed (Pearce 1995). Swiss photographer Karl Ammann has spent years fighting this trade (McRae 1997), and in the late 1990s, conservationists from around the world began efforts to save these beleaguered apes from slaughter.

In the forests of southeastern Cameroon, Ammann and Michael McRae, a journalist, found an infant Gorilla being kept in a dark mud-hut; the tiny animal was cowering in the corner, grinding its teeth and straining against its tether. The owner explained that the Gorilla™s parents had been shot two weeks earlier by a village hunter, the male having been wounded as he charged to defend the family, but escaping. The mother Gorilla died clutching her baby; she was then gutted and carried out of the bush, cooked and eaten (McRae 1997). Malnourished baby Gorillas are kept to be sold to passing trucks, but usually die within days. Ammann, after years of witnessing these tragedies, concluded, "Chimpanzees have the will to live if they're separated from their family, but Gorillas fall into a depressive state, and just give up on life" (McRae 1997). One baby Gorilla photographed by WSPA had been stuffed into a suitcase, where the Gorilla died of starvation after days of suffering (Pearce 1995). Another baby Gorilla was filmed lying dead in a battered cardboard box. CNN reporter Gary Streiker filmed an orphan baby Gorilla, tied on a string leash, being kicked and taunted. Huge cargo boats chug along the Congo River and other waterways of the Central African rainforest that serve as highways, carrying hundreds of orphan Chimpanzees and Gorillas to markets, stuffed in boxes

and bound with rope. fiDown the Dark River,fl a 1996 film by CNN, captured the squalid and cruel conditions that baby Chimpanzees endured on these boats. When sold as pets, baby Chimpanzees are often placed in outdoor dirt yards, lonely, solitary little gnome-like figures with sad eyes, hugging themselves or clinging to dirty cotton cloths. When they grow older and become strong and difficult to manage, they are usually killed and eaten (McRae 1997).

The total Lowland Gorilla population is not known with any certainty, and "guesstimates" of 100,000 put forth in 1985 are probably greatly exaggerated. Their true numbers are probably half that, and in steep decline (McRae 1997). Several bushmeat hunters were interviewed in fiThe Bush Meat Trade,fl a film shown on the National Geographic Explorer television series in 1995. When asked why they shoot these magnificent and protected animals, the hunters defended themselves by saying: "What's wrong with killing a Gorilla? They're fierce." One of the hunters told McRae that he was sure Gorillas were plentiful: "In Cameroon there are a million Gorillas. Three weeks ago, I saw sixty in one day. I shot three and then stopped . . . Why should I feel bad for a Gorilla? He is just a stupid animal" (McRae 1997). The West African country of Gabon also has markets where huge amounts of bushmeat are offered for sale, including Chimpanzee heads and Gorilla parts (Walters 1996).

Monkeys are killed on sight by the hundreds by hunters for sale in meat markets. Traders on the boat trip filmed in fiDown the Dark Riverfl were transporting some 30 or more dead monkeys, strung together with cord wrapped around their necks. These colorful and delicate rainforest primates are rapidly disappearing throughout their range. Monkeys from the forests surrounding the Congo River are bought by traders from hunters along the boat routes, or by logging truck drivers, and sold for $1 each in cities such as Kinshasa to be smoked for human consumption. Some traders traveling on riverboats specialize in bushmeat and barter with local people for monkeys, apes, turtles and other animals, some kept alive for the journey to preserve freshness of the meat, and others dead, stacked in piles.

WSPA has launched a campaign called EscAPE to encourage African governments to enforce existing hunting laws and police the trade in ape meat and body parts. WSPA personnel have rescued baby Chimpanzees and Gorillas from being sold as pets or abandoned, placing them in zoos or sanctuaries. A conference organized by WSPA invited loggers, conservationists, government representatives and organization representatives to discuss the bushmeat market and possible ways of ending it. The loggers boycotted the meeting, but others attended and, after two days, drafted a long list of resolutions, including enforcing existing laws, instilling conservation ethics, and restricting the logging trade (McRae 1997). In December 1995, Ammann and WSPA presented information on the trade to a committee of the European Parliament, distributing their report (Pearce 1995), and at a subsequent meeting of Afro-Caribbean-Pacific nations and the European Union, 140 delegates passed a resolution urging action (McRae 1997).

The bushmeat trade has become the foremost threat to wildlife in Central and West Africa's forests, an even greater threat than logging (McRae 1997). Urgent action to substitute other sources of income is needed. Ecotourism has been suggested, as well as employing hunters to conduct wildlife counts and become rangers. To date, no coherent program has been set into place, and hunters claim that they will continue to kill large numbers of animals until they find an adequate substitute.

Bonobos (*Pan paniscus*), or Pygmy Chimpanzees, number only about 13,000 in a restricted area of the former Zaire's dwindling rainforests. As the most endangered of the apes, exploitation could cause their extinction. WSPA documented illegal trade in these primates (Pearce 1995).

A study of the bushmeat trade in western Cameroon found serious declines in several other species of primates, caused by the meat trade. The rare Preuss's Guenon (*Cercopithecus preussi*) and the highly endangered Drill (*Mandrillus leucophaeus*), a large monkey listed on the US Endangered Species Act and Appendix I of CITES, are also being hunted for market sale. In one hunt alone, 30 Drills were killed (King 1994). Troops in the area have declined in number. One monkey, the Russet-eared Guenon (*Cercopithecus erythrotis camerunensis*) has been hunted to extinction there, and all primates from the Mount Manenguba region have declined dramatically (King 1994). In Sierra Leone, 300 tons of monkey meat are exported to Liberia each month, decimating wild populations of Red

Colobus (*Procolobus badius*) and Diana Monkeys (*Cercopithecus diana*). All these primates are listed by the *2000 IUCN Red List of Threatened Species* as Endangered. Scientists predict extinction in the region for the Red Colobus in 10 years, and the Black and White Colobus (*Colobus guereza*) in 20 years. Gabonese markets also offer various species of monkeys for sale. In one market, three small monkey heads were lined up on a gutter curb. Two of the faces were expressionless, and the third was open-mouthed, its eyes staring under furrowed brows, "as if frozen in a final, terrified gaze" (Walters 1996).

The Gabonese bushmeat trade, while not linked to commercial logging, has nevertheless grown in size and, in 1993, accounted for almost 11 percent of the country's gross domestic product (Walters 1996). A 1993 study found that, in a single city, more than 5,000 animals of 43 species of mammals, reptiles and birds were sold per year. Guenons; the magnificent and colorful Mandrill (*Mandrillus sphinx*), a Vulnerable species; Black Colobus; Chimpanzees; Gorillas; four species of duiker antelope; pangolins; Brush-tailed Porcupines; mongooses; genets; civets; and African Golden Cats are among the mammals killed for sale in Gabonese markets (Walters 1996). Birds being sold in these markets include crowned eagles, vultures, hornbills, guineafowl and plaintain eaters (a type of turaco). Pythons, Gabon Vipers, Nile Monitors, hinge-back tortoises and even threatened West African Dwarf Crocodiles (*Osteolaemus tetraspis*) were being marketed. Even animals protected under Gabonese law as endangered species are offered openly for sale. In addition to Gorillas and Chimpanzees, the Giant Pangolin (*Manis gigantea*), a race of the Potto (*Perodicticus potto*), and Demidoff's Dwarf Galago (*Galagoides demidoff*), nocturnal primates, all threatened species, could be obtained clandestinely (Walters 1996). In some areas of Gabon, high-ranking government--as well as local--officials supply hunters in villages with rifles and ammunition. Hunters then decimate wildlife and exchange the dead animals with traders for beer or soap. The traders then sell them for large amounts in city markets (Walters 1996). Hunting takes place throughout the forests, which still cover much of the country, and even in protected reserves where hunting is not allowed (Walters 1996).

An environmental organization, ECOFAC, has set up an ecotourism project to attract visitors to one of Gabon's wildlife havens, the Lope Reserve. Paths have been made through the forests, and 24 elevated observation posts have been built by members of the Scottish Primate Research Group, who have spent years habituating mangabeys and Chimpanzees to human contact (Walters 1996). The goal is to provide local communities with an alternate form of income from tourism and, perhaps, to spread the concept throughout the country and elsewhere in tropical forests where viewing wildlife is not as easy as in open savannah habitats.

The wild animal trade of Central and West Africa is obliterating populations of small forest antelope, such as various species of duiker. Twelve species of central and west African duiker are listed in the *2000 IUCN Red List of Threatened Species*. The meat trade and unregulated hunting, accompanied by destruction of forests, are the major threats. These animals are killed by capture in snares, where they may struggle for days. Two small, delicate antelope, both on CITES Appendix II, the Blue Duiker (*Cephalophus monticola*) and Bay Duiker (*Cephalophus dorsalis*), are trapped in wire snares or taken in pit traps in the Cameroon (King 1994). Dismembered duikers were seen in a market in Libreville, the capital of Gabon, in 1995 (Walters 1996).

Illegal snaring for antelope meat in national parks has been a major threat to Mountain Gorillas (*Gorilla (gorilla) beringei*), who number only about 650 animals. Many have lost their hands to snares, but some have now learned to recognize these traps and spring them. In 1995, however, a baby Mountain Gorilla strayed from the group and became snared, crying and struggling in terror for almost 24 hours while family members watched helplessly until Virunga National Park guards cut him free. Others have died in these snares.

Congo's national park, Odzala National Park, an area of 1,000 square miles, until recently had the region's only unexploited populations of African Elephants, African Buffalo and other mammals. Because of a lack of guards, poachers are now invading the park. The European Economic Community has agreed to fund the hiring and training of guards, with help from the Congolese army. This country is nearly bankrupt, like neighboring countries, making wildlife protection extremely difficult. Private hunting safaris enter the Congo rainforest and, for a fee, a foreign hunter can kill rare species of antelope and other wildlife.

Those who eat African monkeys and apes may be risking death. Several people who ate a dead Chimpanzee they found in the forest in Gabon died of the dreaded ebola virus, and the disease threat is not well-known to those who eat the meat of primates. Sooty Mangabeys harbor a virus related to HIV-2, an AIDS-like virus, and McRae (1997) saw a hunter carrying dead mangabeys, dripping blood into scratches on his leg.

In the Amazon, primates are avidly hunted for meat. Russell Mittermeier, head of the IUCN Primate Specialist Group, states that thousands of primates are killed by hunters, causing local extinctions of woolly monkeys (*Lagothrix* spp.) and spider monkeys (*Ateles* spp.) in Peru and Brazil. Forest tribes in Suriname kill very large numbers of primates for food, selling the meat in many local markets. The Wildlife Conservation Society (WCS) has been working with several native tribes in South America, evaluating the effect of their hunting on wildlife. They have found that in many cases, natives were overhunting many animals, causing local extinctions, even when only killing for subsistence. Peccaries of various species have been extremely vulnerable.

Meat Hunting: Page 3

Fruit bats of Asia and Pacific islands are killed in large numbers for food, sold by the tens of thousands to markets in Southeast Asia. Two species of the western Pacific, the Little Mariana Fruit Bat (*Pteropus tokudae*) of Guam and the Mariana Fruit Bat (*Pteropus mariannus mariannus*) of Guam, Rota, Tinian, Saipan and Agiguan have both been exploited so heavily that they are nearly extinct. Both bats are listed on the US Endangered Species Act as Endangered, yet the trade continues. On Sulawesi Island in Indonesia, thousands of bats are caught by young boys using kites to entangle them as they fly overhead. These bats are vital as pollinators of many species of commercially important fruit.

Bushmeat hunters in Indonesia and Malaysia are wiping out the populations of many animals. On the island of Borneo, a study conducted by the Wildlife Conservation Society found that hunting, legal and illegal, was the single greatest threat to wildlife (Bennett 1994). In Sarawak and Sabah, two northern states on Borneo, Elizabeth Bennett and her assistants conducted a three-year study of native hunting. These rural people, who previously had hunted only for subsistence, now hunt to sell the meat to town markets (Bennett 1994). Areas that had been inaccessible were opened up by logging roads, and hunters now swarm in the forests, killing any animal they see (Bennett 1994). Except in the most remote areas, all local people now possess shotguns. Squirrels, which have a great diversity of species on Borneo, nearly disappeared in some areas, along with leaf monkeys (Bennett 1994). Bearded Pigs, macaques, deer and porcupines are hunted, speared and trapped by some tribes (Bennett 1994). The only taboo involves the killing of Orangutans, who are protected by legend. Hunting pressures were so great that Bennett predicted extinctions for many animals, and the effects on the forest ecology were equally dire, as seed dispersers are killed off (Bennett 1994). WCS is working with local peoples to educate them about the effects of their hunting, with the cooperation of the Forest Department of Sarawak and the Wildlife Department of Sabah (Bennett 1994).

On the neighboring island of Sulawesi, formerly known as Celebes, WCS conducted a similar study in the Tangkoko-DuaSudara Nature Reserve. The study found that in the past 15 years, populations of the endemic Bear Cuscuses (*Ailurops ursinus*), bear-like marsupials who hang by their prehensile tails from branches, had declined by 95 percent from hunting (Kinnaird and O'Brien 1996). Crested Black Macaques or Celebes Apes (*Macaca nigra*), tailless, all-black monkeys found only on Sulawesi and listed as Endangered by the *2000 IUCN Red List of Threatened Species*, have declined by 90 percent, due in large part to meat hunting (Kinnaird and O'Brien 1996). An extraordinary turkey-like bird that incubates its eggs in large, leaf mounds, the endemic Maleo (*Macrocephalon maleo*), a Vulnerable species (BI 2000), has declined 75 percent from hunting (Kinnaird and O'Brien 1996). Other endemic species affected by this hunting are the Mountain Anoa (*Bubalus quarlesi*), a CITES Appendix I threatened dwarf buffalo found only on Sulawesi that is on the verge of local extinction, and the threatened, gargoyle-headed

Babirusa (*Babyrousa babyrousa*), a tusked wild pig, whose total wild population is about 5,000 (Kinnaird and O'Brien 1996). Highly organized networks hunt and trade the meat from these threatened species. Some dealers acquire animals on order for traders in North Sulawesi by driving up to 375 miles to buy Babirusa and other meat from forest hunters (Kinnaird and O'Brien 1996).

When native peoples cease hunting for subsistence only and begin hunting for markets, wildlife can be decimated quickly. Even subsistence hunting has been shown to be detrimental in some areas, but when wild animal meat becomes an economic commodity, overhunting usually results. Market hunting in the United States caused the extinction of the Passenger Pigeon (*Ectopistes migratorius*) and Labrador Duck (*Camptorhynchus labradorium*). The Eskimo Curlew (*Numenis borealis*), heavily hunted for meat in the 19th century, is probably extinct as well. The American Bison, Elk, White-tailed Deer and many waterfowl species also nearly disappeared. Following the 19th century slaughters that decimated these animals, laws banning the sale of wild meat from mammals and birds were enacted and remain in force today. In other parts of the world, only extinctions may bring about strong legislation banning market hunting of wildlife.

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Persecution and Hunting

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Roman Slaughters

The tradition of killing animals for pleasure has a long history in Asia and Europe. So popular was hunting in ancient Rome that mosaics and paintings often depicted this pastime as a heroic activity. Slaughtering animals was considered a form of entertainment, and people scoured the countryside for bears, Lions, stags and boars to pursue with spears and dogs (Attenborough 1987). As the Roman Empire grew to encompass the entire Mediterranean basin, its citizens traveled throughout the region to hunt and bring back animals to be killed in primitive contests in the coliseums of Rome and other cities. The coliseum games continued for more than 400 years in more than 70 amphitheaters, the largest seating up to 50,000 people on stone benches arranged around a central arena (Attenborough 1987).

Roman emperors curried favor with the public by upstaging their predecessors in killing more animals and producing more spectacular displays of slaughter (Morris 1990). Emperor Titus inaugurated the Roman Coliseum by declaring 100 days of celebration, during which enormous numbers of animals were speared by gladiators. On the opening day, 5,000 animals were slaughtered, and over the next two days, 3,000 more were killed (Morris 1990). The caged animals were kept underground in dungeons where they were not fed, and on the day of the festival, they were hauled in their cages onto lifts that brought them into the center of the arena. As the crowd roared with excitement, drums were beaten, trumpets blown, and the terrified animals were set loose (Attenborough 1987). Sometimes the animals were goaded to attack one another, and at other times, men armed with spears and tridents pursued them around barriers made from shrubs in imitation of hunts in the wild (Attenborough 1987). One arena hunt resulted in the killing of 300 Ostriches and 200 Alpine Chamois (Morris 1990).

Lions, Tigers, bears, bulls, Leopards, Giraffes and deer died after being tormented, stabbed and gored (Morris 1990). Big cats that had been starved were released into the ring where a human slave or prisoner of war was lashed to a post; the animals clawed at the person before they themselves were speared and stabbed by gladiators (Attenborough 1987). In some of the larger slaughters, 500 Lions, more than 400 Leopards, or 100 bears would be killed in a single day (Morris 1990). Hippos, even rhinoceroses and crocodiles, were brought into these arenas, and sometimes gladiators employed bizarre methods of killing such as decapitating fleeing ostriches with crescent-shaped arrows (Morris 1990).

The Roman audiences cheered these brutal slaughters enthusiastically as a rule, but when 20 elephants were pitted against heavily armed warriors, the screaming of these gentle animals as they were wounded caused the crowd to boo the emperor for his cruelty (Morris 1990). This did not stop their use in the games however. These slaughters virtually eliminated large mammals from the Mediterranean area. North African Elephants (*Loxodonta africana*) were exterminated, having been hunted and captured to die in these arenas (Leakey and Lewin 1995). Elephants were also used by the Romans for transport and even conscripted for battle by Hannibal, a Carthaginian general who used them in a deadly march across the Alps, in which all the elephants died of exposure. Romans were probably the key element in the disappearances of the Asian Elephant (*Elephas maximus*) from West Asia as well (Leakey and Lewin 1995).

Prior to the expansion of the Roman Empire, Atlas Bears (*Ursus arctos crowtheri*) lived in the mountains and forests of North Africa, the only bears on the African continent. Named for their last refuge in the Atlas Mountains of Morocco, they were a race of the Brown Bear which is native to Eurasia and North America. North Africa was the species' most southerly distribution. When Romans entered North Africa, they cut the forest habitat of this bear and slaughtered thousands for sport. Others were collected for coliseum combat, where they were attacked by smaller animals, or gladiators wielding axes, spears and other weapons. Over the centuries, the Atlas Mountain forests were leveled for building materials, and colonial landowners used the cleared land for grazing livestock (Day 1981). The

Atlas Bear became restricted to Mount Atlas, where an 18th century French naturalist discovered a fresh skin, upon which the first scientific description was based (Day 1981). Even as late as 1830, the bears were common enough to be captured and sent to French zoos. In 1840, an English scientist concluded that this bear, smaller than the American Black Bear (*Ursus americanus*), was a distinct subspecies. It was stocky, with a short face, blackish-brown, shaggy fur on its back, and orange-rufous fur on its belly (Day 1981). This differentiates it so much from the Brown Bear that modern taxonomists might consider the two distinct species. Although Atlas Bears became increasingly rare, they received no protection from hunting, and the last of these bears were shot around 1870 (Day 1981).

Herodotus and Aristotle, philosophers of ancient Greece, wrote that Lions once lived in that country (Attenborough 1987). Two thousand years ago, the range of these big cats extended eastward in a continuous band to India and Pakistan and throughout the African continent. The Lion disappeared at an early time from Italy and Greece after being hunted and captured by the thousands for gladiator spectacles. When European Lions had been killed off, Romans turned to North Africa. The Barbary or Atlas Lion (*Panthera leo leo*), once distributed through much of the region north of the Sahara, fell victim to hunting and Roman Coliseum games. Known for its enormous mane, which covered virtually half its body, the male Barbary Lion was one of the largest of all races of Lions (Day 1981). It was also the nominate, or first subspecies named. This massive animal weighed as much as 500 pounds and measured up to 10 feet long from the tip of his nose to the tip of his tail (Day 1981). After centuries of hunting, persecution and habitat loss, these Lions withdrew to remote forests, where the last of them were systematically hunted down. Arabian tribesmen in Tunisia and Algeria chased them for sport, and later, French colonial governments paid bounties for their skins; by the 19th century, hunters had exterminated the last of the lions in Algeria (Day 1981). Government lists recorded the bounty fees paid, with fewer each year; only one skin was submitted for payment in Algeria in 1884 (Day 1981). Their final refuge, like the Atlas Bear's, was the wilderness forest of Morocco's Atlas Mountains, where hunters killed the last one around 1922 (Day 1981). Although officially extinct, some of these Lions may still survive in captivity. Certain circus and zoo Lions resembling the original Barbary Lion have been identified, and an effort is being made to gather a breeding colony of these animals. Whether they are, in fact, direct blood lines from the original North African Lions remains to be seen.

By the 13th century, Lions had been eliminated in the eastern Mediterranean; they disappeared from Iraq, Iran and Pakistan by the 1800s (McClung 1976). The last Lion in the Saudi Arabian peninsula was killed in 1923. For most ancient cultures of the Middle East and West Asia, killing one of these great cats, especially a large male, was considered a heroic deed worthy of being recorded in paintings and mosaics. Many such art works remain from Assyrian and other West Asian cultures. By the mid-19th century, Asiatic Lions (*Panthera leo persica*) had become confined to India, but were still widespread in that country (McClung 1976). During the last half of the 19th century, however, Indian Lions came under siege by British Colonial officers, who traditionally proudly took a Lion pelt back to England; a single hunter boasted of shooting 300 Indian Lions in 1860 (IUCN 1978). Under such pressure, Lions disappeared from all of India, save the Gir Forest in the southwest, by 1884 (IUCN 1978). In 1900, protection was finally accorded the last of these Lions, when their populations had been reduced to fewer than 100 animals (McClung 1976). Today, the Gir Forest Lions number a few hundred animals, all that remain of these proud cats on the Eurasian continent. Confined to a habitat that was rapidly being whittled away by villagers cutting firewood, and overgrazed by livestock, the Gir Lions are now protected in the Sasan Gir National Park of western India where, in recent years their population has increased.

Hunting by Romans and later peoples, combined with capture for the colosseum games, devastated the wildlife of North Africa and the entire Mediterranean region. Large predators, as well as deer and other ungulates, disappeared altogether or become endangered. Few conservation programs exist to protect remaining populations from hunting and persecution.

Predator Prejudice

The Roman tradition of persecuting predators spread throughout Europe and intensified in proceeding centuries, reaching superstitious depths in the Middle Ages. Beliefs that fiwerewolvesfl existed resulted in the persecution of wolves in Europe and Russia that continues today. Fairy tales are still recounted to children, in which wolves and bears are depicted as voracious killers. These stories, especially those by the Grimm brothers, frighten small children with tales of wolves, that pursued and ate small children and adults alike. "Little Red Riding Hood" and other stories instilled horror and hatred of predators. In Russia, the destruction of wolves was considered a great benefit to people, as well, with folklore embodied in tales such as "Peter and the Wolf." Persecution of wolves in that country continues to this day. With the spread of domestic livestock throughout Europe, official programs were instituted to destroy wolves (McIntyre 1995). Wolves were not the only animals killed in these programs. Lynx and Brown Bear were also eliminated from all but the most remote areas of Western Europe.

When Europeans settled in America, they brought these prejudices with them, treating native predators as vermin. Most colonies passed laws similar to Massachusetts' 1630 law requiring that "every English man that killeth a wolf . . . shall have allowed him one penny" (McIntyre 1995), and South Carolina's 1695 "Act for Destroying Beasts of Prey," which mandated that all Native American braves be required to bring in one skin of a wolf, panther, or bear, or two Bobcat skins each year. If he failed to do so, he would be "severely whipped," but if more than one skin was provided, he would receive a reward (Nowak 1972). In the East, these programs systematically killed off Gray Wolves, bears and Cougars. Large predators were effectively eliminated in the eastern states by the early 1800s, except for the Black Bear, which became greatly reduced in range and numbers.

The US government ran predator control programs throughout the country. Traps and poisons were the major tools used. Poison was liberally spread over most of the West. Thallium sulfate, strychnine, Compound 1080, and cyanide were distributed in great quantities, killing not only wolves, bears, and Coyotes, but foxes, weasels, ferrets, eagles and other birds. Any animals that ate the poisoned bait died, as well as those feeding on their carcasses. All these poisons caused a painful death, and most killed slowly. Poisoned animals could take hours to die from Compound 1080, and sometimes days after ingesting thallium sulfate. Strychnine, an extremely painful poison, can make water supplies lethal, killing humans, dogs and livestock. The wild predators that consumed Strychnine would vomit while dying from convulsions. Their bodies spread more poison, which remained toxic for a year or more.

Trapping was equally indiscriminate in its victims. Irrational prejudices against predators resulted in the total extermination, even in remote wilderness areas, of America's wolves and almost all its bears through bounty systems, federal subsidies and government control programs. Trappers and poisoners combed the countryside, randomly placing poison and traps.

Prejudice against predators affects a wide spectrum of animals, from foxes and bears to bats and birds of prey. Although the number of species that have become threatened as a result of control programs and random killing is less than those threatened by habitat destruction, the ecological consequences have affected a host of species within their habitats. These animals have co-evolved with their prey, the wolf making the deer fleet; wild cats making gazelles, zebras and hundreds of other ungulates agile. Although there is dispute as to the effect that predators have on the populations of their prey, overpopulations of deer and other ungulates have occurred in many parts of the world where predators have been eliminated. When ungulates overpopulate, they tend to overgraze their habitats, eliminating many types of vegetation, as well as birds and other wildlife dependent on that vegetation for feeding and habitat. Thus, thousands of species may be adversely affected when predators are destroyed.

Many species of snakes, as well as small carnivores such as foxes, eat large numbers of rodents, performing

important roles in preventing population explosions of these prey animals. Bats, as the most important predator of insects, control insect populations, as documented by many scientific studies. These mammals, although more abundant in number and diversity than carnivores, have declined radically in recent years, as evidenced by the enormous number now listed in the *2000 IUCN Red List of Threatened Species*. From a humane point of view, predator control has brought out the worst in human character, suppressing reason and compassion to allow fear and hate to dominate. As science has learned more about the importance of predators, and they are being protected and reintroduced in a growing number of areas in the world, prejudices remain, as do centuries-old ways of raising livestock that involve killing predators. These latter problems need to be addressed with the same vigor that has elevated predators to their rightful place at the top of their food chains in the eyes of conservationists and scientists.

Wolves, Wild Dogs and Foxes

Wolves have suffered more inhumane treatment and loss of range and populations than any other predator. The history of their survival and disappearance in various parts of the world is a reflection of the overwhelming importance of people's attitudes toward animals. When emotions, especially fear and negative superstition, rule people's minds, wolves can be destroyed on the basis of ignorance about their real threats to people and livestock. On the other hand, when people are aware of biological facts about the wolf and its ecological role, behavior, value to ecosystems, and the truth about its history of not attacking people, prejudices tend to dissipate. Native Americans had a natural affinity and respect for wolves, calling them "brother." The wolf's very survival as a species depends on its being treated with tolerance and respect. Gradually, this is happening in many parts of the world. Education and a change in government attitudes in many countries are needed to conserve this species, along with better ways of raising livestock.

Wolves, Wild Dogs and Foxes: Page 1

Prior to European settlement of North America, two wolf species lived throughout the forests of the East: the widespread Gray Wolf (*Canis lupus*), the same species that is native to Eurasia, and the Red Wolf (*Canis rufus*), a uniquely American species of the Southeast. Some biologists estimate that there were 2 million wolves on the continent at this time. European settlers entered the American wilderness and set about killing off these animals. The book, *War Against the Wolf. America's Campaign to Exterminate the Wolf*, by Rick McIntyre (1995), chronicles the history of this extermination program, based on historical and modern documents. Colonists dug pit traps and filled them with vertical stakes, which impaled wolves falling onto them. When hunters found an animal in the pit, they would leap in and ham-string the cowering wolf. John James Audubon described a farmer who captured wolves in a pit trap, severed the tendons in their hind legs, then tossed the crippled animals into a pack of dogs which tore them

apart (McIntyre 1995). The new colonists and their professional hunters set toothed traps that held the animal's leg while the teeth broke through its skin, wounding and breaking bones. Some who captured wolves cut off the lower jaw and turned the animal free to starve (Laycock 1990). Others set them afire, or started forest fires to rid the woods of wolves (Laycock 1990). Strychnine and thallium were placed in meat baits. Wolf pups were ripped apart by dogs, stomped to death, or burned alive in their dens. One predator hunter threw baited fish hooks, attached to lines, into wolf dens, waited until the pups swallowed the hooks, which embedded in their stomachs, then dragged them out of the den and killed them (McIntyre 1995).

Europeans were convinced that wolves hunted humans, even entering towns to kill children as they slept. In truth, wolves are neither ferocious nor killers of people. No case of a non-rabid North American wolf killing a human has ever been documented (McIntyre 1995, Nowak 1999). Very passive when trapped, they do not even attack the trapper as other predators might. Native Americans took wolf pups out of dens for pets without ever being attacked by the parents.

Red Wolves, named for their reddish-brown coats, had other color phases as well. Prior to their near-extinction, they exhibited a range of colors from black to gray and brown. The genes for these color phases were eliminated along with the wolves themselves in predator-control programs. Originally, this wolf inhabited the United States as far west as Oklahoma and eastern Texas, north to Indiana, as well as the southeast. The Red Wolf is the only surviving wolf that evolved in North America. This species and its ancestor, *Canis edwardii*, had been resident in forests as far north as Pennsylvania since the middle Quaternary epoch (Nowak 1979). Dr. Ronald Nowak, an expert on wild canids, maintains that the Red Wolf is a far more ancient species than the Gray Wolf. The latter species is thought to have evolved more recently in Eurasia, during the early Pleistocene, and migrated into North America across the Bering land bridge that linked the continents (Nowak 1979).

Weighing only 20 to 40 kilograms (44 to 88 pounds), and 660 to 790 millimeters (26 to 31 inches) tall at the shoulder, the Red Wolf is larger than the Coyote (*Canis latrans*), but smaller than the Gray Wolf. Mating for life, it breeds in February or March, producing two to six pups in March or April. The pair dens in hollow logs or along banks of canals or ditches. These wolves did not usually form packs, but were most often seen in pairs or small family groups. They were systematically trapped, shot and poisoned out of their range. From the 17th century onward, in state after state, these wolves were exterminated to the last animal, pushing this species toward extinction. Federal predator-control programs took some 50,000 Red Wolves from 1937 onward, until they were virtually extinct in the wild (Laycock 1990). It was not until 1962 that this wolf's highly endangered status received any attention from biologists and wildlife officials. Still, no action was taken to stop state trapping and predator-control programs for another 11 years.

By the 1970s, the Red Wolf had been completely exterminated, except a small population that survived in one county in southwestern Louisiana and in adjoining areas of eastern Texas (Carley 1975). Coyotes had moved into the range of the Red Wolf and interbred with some of the last members of the species. This hybridization spelled the demise of wild Red Wolves. It has been suggested that this interbreeding occurred only because Red Wolves had become so rare that they were unable to find mates of their own species. A live-trapping program to capture the last, pure-blooded specimens, as the only way of saving the species, began in 1973 in Texas, funded by the US Endangered Species Act (ESA). Fewer than 100 animals remained. After capture, X-rays were taken of these animals' skulls to determine which were pure-bred and which were hybrids, based on their skull shape and dimensions.

A number of these hybrids, as well as the pure-blooded Red Wolves, were in poor health from mange, heartworm and other parasites when captured (Carley 1975). Their last attempt to survive in the wild had obviously been a difficult one. Their remaining habitat in Texas and Louisiana had become a mosaic of agricultural and residential development, leaving little natural forest. Moreover, they were under constant threat from trappers and hunters. After five years of live-trapping, only 40 pure-blooded Red Wolves were identified, and they were sent for captive breeding at the Point Defiance Zoo in Tacoma, Washington. No further Red Wolves were found, and in 1979, Howard McCarley and Curtis Carley of the Red Wolf Recovery Team, authorized under the US Endangered Species Act, announced in a status

report, "Recent findings indicate that the only extant subspecies (*Canis rufus gregoryi*), once occurring from eastern Texas to eastern Mississippi, for all practical purposes is extinct in the wild" (McCarley and Carley 1979). The other subspecies of the Red Wolf, the Florida Red Wolf (*Canis rufus floridanus*), had become extinct by 1917 (Day 1981). So many wolves of the Florida race, which once ranged into Georgia and southern Tennessee, were black, that this wolf was originally named the Black Wolf. This genetic strain is now lost.

Of the 40 captive Red Wolves, 14 were selected to form the nucleus of a Fish and Wildlife Service-sponsored captive-breeding colony (Nowak 1999). In 1977, offspring were successfully produced, and by 1989, there were 83 descendants, and the last surviving wild-caught Red Wolf died (Nowak 1991). In 1993, the captive colony consisted of more than 187 animals in 31 breeding facilities. By 1995, there were 289 living descendants from the original wild Red Wolves, the majority in Point Defiance Zoo in Tacoma, Washington (Nowak 1999). In the mid-1980s, reintroduction programs began with the release of several of the captive-bred wolves to the wild. This was the first time the American government had ever sought to introduce and protect wild populations of wolves, instead of eliminating them. Since the Coyote is now present throughout the Red Wolf's original range, attempts were made to find reintroduction areas without Coyotes to prevent hybridization and competition. In 1987, four pairs of Red Wolves were reintroduced into the 120,000-acre Alligator River National Wildlife Refuge, an island in North Carolina without resident Coyotes. A pair released on Bulls Island in Cape Romain National Wildlife Refuge in South Carolina produced two pups in 1988. These pups were captured and released in the Alligator River Refuge in 1989. Another pair, introduced to Horn Island off the Mississippi Coast, produced seven pups in May 1989. By the close of 1993, 46 to 60 animals survived in these newly wild populations by Fish and Wildlife Service counts.

In 1991, a pair of Red Wolves and their two pups were set free in Great Smoky Mountains National Park in Tennessee. Jan DeBlieu, a writer on endangered species, witnessed the release of the wolf family (McIntyre 1995). This area has resident Coyotes, which arrived in the mid-1980s, and the interaction between the two species will be closely watched. Several Coyotes and the adult Red Wolves have radio transmitters and were tracked by a number of biologists after their release. DeBlieu was present when, soon after their release, the male and pups traveled 2 miles away from the female, who lay quietly in a field. Suddenly the researchers heard the prolonged, low howl of the male wolf and high-pitched yaps of the pups, a song "not heard in the Smokies for one hundred years" (McIntyre 1995). They were calling the female, who ran toward them. This national park receives 8.6 million visitors a year--more than any other park in the system. The visitors tend to stay near roads, however, and most of the park is roadless wilderness. Prey is abundant, and both the adults and pups began catching rodents and rabbits, hunting at dawn to avoid tourists during the day (McIntyre 1995). By late summer 1994, there were seven Red Wolves in Great Smoky Mountains National Park. Two more family groups were released the following year, but the available prey in Great Smoky Mountains National Park is limited in the mountainous terrain (Rancourt 1997). As many as 26 wolves lived in the park in 1997 (Rancourt 1997). A few pairs have produced young.

For the most part, these reintroduced wolves have survived with few conflicts with local people, mainly due to the extensive education programs and hearings held by the Fish and Wildlife Service in each area prior to releases. Some private landowners in North Carolina became apprehensive about the potential threat to children and livestock. The Fish and Wildlife Service has paid claimants for losses even when no proof was submitted that it was, in fact, a wolf at fault. One livestock owner admitted that the Red Wolves had become "good neighbors." Yet even these limited reintroductions have provoked resentment in some local communities which harbor ancient prejudices about wolves. The North Carolina state legislature passed a law early in 1995 that defied the US Endangered Species Act, allowing people to kill wolves that attacked livestock. The Fish and Wildlife Service accommodated these concerns by changing its policy in April 1995 to allow killing of Red Wolves thought, but not proven, to be attacking livestock in North Carolina and Tennessee. One of the first wolves killed, male number 464, was shot in 1995 in North Carolina by a landowner who caught him digging under his dog's pen. This wolf had been released the previous year near Alligator River National Wildlife Refuge, but prey was scarce, so Fish and Wildlife Service personnel recaptured him and freed him on the mainland. Number 464 had not been guilty of preying on livestock.

Further incidents between residents and Red Wolves occurred in 1997 and 1998, with wolf pups that were attempting

to disperse into new territory being trapped. One young wolf that had been taken in a leghold trap in North Carolina was rescued by the Fish and Wildlife Service and returned to a penned enclosure in 1998. The local county representative stated that wolves were unwanted intruders and would be dealt with by residents. This does not bode well for reestablishment of these wolves.

If the Red Wolf survives this irrational prejudice, it may reoccupy many of its original haunts. The threat of hybridization with the Coyote will remain, however, and without corridors of habitat to link reintroduced populations, these wolves risk becoming inbred. With education of the public, one day the Red Wolf may be restored as a natural predator, benefiting its prey and ecosystem.

Wolves, Wild Dogs and Foxes: Page 2

Unlike the Red Wolf, Gray Wolves traveled in large packs in the Great Plains of the West. Many of the wolves painted by George Catlin, the great 19th-century artist of Native Americans and wildlife of the Plains, were beige or pure white, as are many of the wolves of the grasslands of northern Canada. Early hunters killed wolves for their pelts by trapping, poisoning and shooting. Many were used for target practice in the open country. When livestock ranchers took over huge tracts of land in the West, the Gray Wolf became a target for total extermination. Cowboys often roped wolves and dragged them to their deaths across rough ground (McIntyre 1995). Federal trappers used even more brutal killing methods (McIntyre 1995).

James Josiah Webb, who wrote a memoir of events in the Santa Fe, New Mexico, area from 1844 to 1861, recounted that two men conducted a wolf-killing operation by spreading strychnine bait placed in chunks of bison meat around the prairie. The number of wolves that once inhabited the region was so dense that they found 64 dead wolves within 1.5 miles of their camp in a single day after a poisoning; they bragged that they earned $4,000, an enormous sum in those days, by selling wolf pelts (McIntyre 1995).

As wolves were exterminated in one state or territory after another, a few of these intelligent animals managed to escape traps, guns and poison, earning the label of "outlaws." These wolves ranged alone or in small packs, and in the last days of the western wolf, some trappers spent months or years in determined pursuit of them. The ability of these wolves to elude their persecutors were truly amazing. One of the most famous such cases was described by Ernest Thompson Seton, an English artist and writer, in *Wild Animals I Have Known* (1899). Based on fact and documented by photographs, it concerned Lobo, an enormous wolf, called "The King" by Mexican residents who lived near a huge cattle ranch in northern New Mexico. For many years in the 1890s, Lobo led a pack of five wolves. He had a distinctive, deep howl that ranchmen recognized among the howls of the other wolves. He was by far the largest wolf in the pack and exceeded the size of other wolves in the region. Whereas most wolf paws measured 4 3/4 inches, Lobo's were 5 1/2 inches long. His mate, whom the Mexicans called Blanca, was a large, magnificent white wolf.

These wolves, like many others of the West during this period, had been deprived of their natural prey, White-tailed and Mule Deer and Elk, which had been hunted out by settlers and replaced with livestock. The wolves turned to livestock as the only large prey available and, in doing so, became the target of ranchers' wrath. Western ranchers, like many livestock owners in Europe, believed that they should be able to release cattle to roam free without herding them into shelter at night. This situation had existed in Western Europe after large predators were eliminated from all but the most remote areas. In their new ranches, allocated to them by the government, ranchers sought to recreate the European model. This required the destruction of large predators.

Lobo and his pack refused to eat dead animals that they encountered, apparently to avoid poison, and survived on calves and sheep that they killed themselves. When Lobo and his pack killed a cow, ranchers immediately put poison in the carcass. But when the wolves returned the next day to eat, they somehow knew which parts of the carcass were

poisoned, and pulled out the poisoned chunks, throwing them aside, eating only the unpoisoned portions. Lobo also avoided the traps set for him and hid from hunters on horseback who pursued him. Trappers came from great distances to claim the high bounty on Lobo, but all failed to kill him. Ernest Thompson Seton decided to try to kill Lobo himself for the $1,000 bounty. He scattered poisoned baits, covering the human scent with other odors, and the following day, found that one after another of the baits was gone. Assuming that he would come upon the body of Lobo, he was surprised to find his five baits in a pile. Lobo had picked them up, one after another without eating them, and left them as a message to Seton. Seton obtained special steel jaw leghold wolf traps and set them in concealed places in Lobo's territory. When he came out to check the traps, he found Lobo's tracks leading from trap to trap. The canny wolf had discovered each of the traps during the night, scratching earth away to reveal the chain and trap, continuing from trap to trap until he encountered one in the center of the trail. Lobo then retraced his steps, placing each paw exactly in its old track until he found no more traps, using his paw to flip stones and earth clods to spring every trap.

Seton finally succeeded in trapping Blanca by setting hidden traps among parts of a cow carcass and covering the area with Coyote scent. Lobo avoided the traps, but Blanca made a fatal error and blundered into one. When Seton and the others found her dragging the heavy trap, she turned to fight, howling across the canyon. Lobo howled back, while Seton and the others brutally killed her. Throwing lassos over her neck and holding the ends of the ropes, they galloped horses in opposite directions until her body was torn apart. When he wrote of the event years later, Seton (1899) called the killing a tragedy. They heard the howls of Lobo for days afterward. Seton described it as having "an unmistakable note of sorrow in it, now. It was no longer the loud, defiant howl, but a long, plaintive wail." When they found Lobo's tracks at the spot where Blanca had been killed, Seton reflected, "Now, indeed I truly know that Blanca was his mate."

Soon afterward, Lobo came near the ranch house. His tracks showed that he had galloped about in a reckless manner before he blundered into a trap set in a pasture. He was able to pull out of it, but Seton then set 130 steel jaw leghold wolf traps in groups of four on every trail leading into Lobo's home canyon, and dragged Blanca's body around the area to leave her scent. He even removed one of her paws, with which he made a line of tracks on the soil covering each trap. Within days, Lobo was caught with all four legs in a trap set, having followed Blanca's scent and forgetting all caution. When Seton approached the trapped wolf, Lobo managed to stand, in spite of severe injuries, and howled his deep call, but no members of his pack responded. Seton and others wrapped ropes around his neck, put a stick in his mouth and lashed his jaws closed. His feet were tied, and when he was placed on Seton's horse, he refused to look at any of his captors. At the ranch, Seton placed a collar around his neck, secured him to the pasture with a strong chain, and Lobo lay calmly, gazing across the prairie.

When Seton came out the next morning, Lobo was dead. On measuring his body, Seton found that Lobo weighed 150 pounds and was 3 feet tall at the shoulder. He was one of the largest wolves ever trapped in the Southwest. The largest Gray Wolves are native to northern Canada and Alaska and weigh up to 176 pounds, but most wolves of the Southwest were far smaller and lighter (Nowak 1991). Scientists who measured the skulls of the pair estimated that Lobo was 4 to 5 years old when he was killed, and Blanca was 7 (McIntyre 1995). Photos of Lobo and Blanca caught in traps are reproduced in Rick McIntyre's 1995 book, *War Against the Wolf*. Lobo and Blanca were exceptional specimens, and their slaughter represented an irreplaceable genetic loss. The treatment they received will remain a blot on human "kind." Lobo was killed on January 31, 1894, near Currumpaw, and his pelt is kept at the Ernest Thompson Seton Memorial Library and Museum at the Philmont Scout Ranch near Cimarron, New Mexico (McIntyre 1995). This experience changed Seton's attitude, and he expressed strong feelings of guilt in his description of his treatment of these wolves.

Government programs did not reflect Seton's newfound sympathy for wolves. In fact, predator-control programs intensified in the early years of the 20th century. Ranchers convinced the federal government to launch an all-out attack on predators, primarily wolves. The Forest Service and the Bureau of Biological Survey used poisons and traps to kill adult animals and many cruel methods to kill the pups in dens in their efforts to try to exterminate the wolf. In 1907 alone, the Forest Service killed more than 1,800 Gray Wolves and 23,000 Coyotes, among other animals

(Laycock 1990). After the US Congress authorized the first substantial appropriation for hiring government hunters in 1915, federal wolf-control programs achieved an unprecedented level. Hundreds of agents combed the most remote wildernesses, spreading poison even where no cattle or livestock grazed. A point system was established; the highest number of points, 15, was accorded for killing a Mountain Lion or a Gray Wolf (Laycock 1990). Hired hunters earning high point totals made the Honor Roll, while others might be fired; they were expected to kill virtually every predator in their assigned area (Laycock 1990).

Within a few decades, many thousands of Gray Wolves had been killed. They were eliminated from more than 95 percent of their range in the lower 48 states by the 1930s (Robbins 1997). A few wolves, using their intelligence and survival senses, managed, like Lobo and his pack, to survive somewhat longer, but they were killed in the end. The Custer Wolf, a large female also known as "Old Three-Toes" because she had lost a toe in a steel jaw leghold trap set by a government trapper, became as infamous as Lobo and Blanca. After her mate and pups were killed, the Custer Wolf survived until caught in a trap that became snagged on rocks (McIntyre 1995).

Vernon Bailey, a biologist with the US Biological Survey, the government agency that later became the Fish and Wildlife Service, conducted wildlife and plant studies as well as predator-control programs. He noted early in the century that the Biological Survey had conducted "the most systematic and successful war on these pests ever undertaken" (McIntyre 1995). The loss of virtually all wolves in the vast area encompassing the lower 48 states may be the most devastating predator-control campaign in history.

If not for the fact that the predator-control programs of the territorial and provincial governments of Alaska and Canada did not succeed in totally exterminating the wolf, the species might be extinct on the continent. Although wolves were persecuted and trapped for their fur in the latter areas, they survived in the far north and in the eastern forests of Ontario and Quebec and have now reoccupied most of their original range in Canada.

The Gray Wolf is able to adapt to a wide variety of habitats and climates, whether searing deserts, shrublands, grasslands, forests of all types, frozen tundra or even marshlands. It had the largest range of any terrestrial mammal on Earth, other than humans (Nowak 1999). Wolves had lived for thousands of years on the continent, their environment and prey altering drastically through the Ice Ages, needing only the presence of large prey to survive. Wolf intelligence, in fact, exceeds that of the domestic dog, which has a brain 31 percent smaller (Busch 1995). In spite of the wolf™s survival abilities, the fragmentation of packs by predator-control agents prevented them from hunting normally and hastened their disappearance soon after control methods began. This need to live in a pack for hunting and companionship made the species vulnerable to extermination. When persecuted, Gray Wolves do not desert one another, and many cases have been documented of wolves sacrificing their lives in an effort to save a pack mate. This altruistic trait also contributed to their extermination. The traits that humans most admire about domestic dogs were inherited from the wolf--loyalty, intelligence, playfulness and affection. Wolf pups were first domesticated by hunter gatherers tens of thousands of years ago, and even after selective breeding by humans in the intervening centuries, they still retain many of the wolf's best qualities.

Wolf packs have a lead pair, known to biologists as the alpha male and female, who are the only members of the pack that produce cubs. They mate for life, and dominate other wolves in the pack. They are usually the fittest and largest. Other pack members challenge for leadership, which can result in a change in the alpha pair. The entire pack, which includes adult females and males and pups from the previous year's litter, cares for the pups, ensuring that the strongest pass on their genes to future generations. Young unmated females and males "baby-sit" the pups when the alpha pair and the rest of the pack are out hunting. When the pups are about six weeks old, their baby-sitters spend hours with them in wrestling matches, games of tag and other rambunctious activities. Within the pack, wolves are extremely friendly and devoted to one another, barking and yipping with delight on meeting, and before and after hunts. They howl at night, communicating with other wolf packs which howl back. Bonds between wolves, especially mated pairs, are very strong, as illustrated by the saga of Lobo and Blanca, and many other cases of wolves in apparent mourning for lost mates have been documented. For many days, one male Mexican wolf, howling plaintively, followed a government trapper who had killed the wolf™s mate and carried off her pelt.

Other species of canids show similar behavior. The African Wild Dog (*Lycaeon pictus*), a highly endangered wild canid, hunts on the African plains in even larger packs than Gray Wolves, numbering up to 26 animals, yet only one female in the pack has pups. The alpha female might have 16 pups, and if another female in the pack has a litter, the alpha female will steal the cubs and nurse them, even if the litter size reaches 20 or more. Fewer than 5,000 of these beautiful animals, sometimes called Painted Wolves because of their black-and-yellow spotted coats, remain in the wild, and they are in steep decline (Nowak 1991). In Zimbabwe, where there are only about 300 to 500 animals, they are still persecuted by farmers. Even in national parks, they often lose prey when chased off by Spotted Hyenas or Lions.

The ecology of the Gray Wolf has been studied since the 1940s, revealing it to be completely different from the prejudicial folklore of Europe. Adolph Murie, one of America's greatest biologists, conducted studies of wolves in Mount McKinley (now known as Denali) National Park, where they were neither persecuted nor hunted. In his study, *The Wolves of Mount McKinley* (Murie 1944), he revealed: "It appears that wolves prey mainly on the weak classes of sheep, that is, the old, the diseased, and the young in their first year. Such predation would seem to benefit the species over a long period of time and indicates a normal prey-predator adjustment in Mount McKinley National Park." By examining the carcasses of Caribou and other mammals killed by wolves in the park, Dr. Murie found that most were in poor physical condition. Wolf packs test their prey by isolating and then chasing individual animals to detect weaknesses, and the majority of their chases do not result in a kill.

In spite of more than 50 years of biological studies of wolves that have shown them to be a positive rather than a negative influence on their prey, there are still many who disagree. Predator-control programs have been authorized in Alaska, Canada and parts of Eurasia in misguided attempts to protect deer, Elk, Moose, American Bison and Caribou. A trophy hunting organization, Safari Club International, paid the British Columbia government to kill wolves in that province (Williams 1991). The real motivation for these eradication programs is often to promote artificial increases in populations of ungulates, such as Moose, Caribou and deer, for sport hunting.

Over the ages, prey species of wolves have evolved to survive their attacks by becoming faster and stronger. The largest and healthiest deer on the North American continent have been found in areas where wolves are resident predators. The number of wolves in a pack varies according to the size of the prey: packs of up to 15 are needed to bring down bison, while packs of seven or fewer hunt deer (Nowak 1999). Wolves hunting large prey run in shifts, with tired members of the pack replaced by rested wolves. They will sometimes need to run for many miles after Caribou, Moose, American Bison or deer before they succeed in singling out one they are able to bring down; an average of only one in 10 chases is successful. Native Americans have always been aware of the important relationship between the wolf and its prey. The Keewatin Inuits have an ancient saying: "The caribou feeds the wolf, but it is the wolf who keeps the caribou strong" (Busch 1995). The healthiest members of each prey species are able to fend off wolf packs, and only in unusual circumstances can wolves kill them. For the vast majority of prey species, wolves sense weakness in their prey, evidenced by body stance, uncoordinated movements, the smell of wounds or, most often, by their lack of endurance when being chased (McIntyre 1995).

When wolves are hunted out of an area with deer and other ungulates, the latter animals often increase in numbers to such great levels that they strip their habitat of vegetation. The overpopulation of White-tailed Deer in many parts of the northeastern United States, especially in suburban locations, has resulted from a lack of natural predators. Their absence has created a major imbalance in eastern forest ecosystems, where they have become so numerous that they consume young trees and new growth on mature trees.

Wolves, Wild Dogs and Foxes: Page 3
Although Gray Wolves were completely eliminated from the eastern states south of Canada and east of Minnesota by 1930 (McIntyre 1995), a few remnant populations survived in northern Minnesota and northern Montana. The first US Endangered Species Act in 1967 listed all wolves in the lower 48 states and Mexico as Endangered. In 1973, another Endangered Species Act was enacted, replacing the 1967 Act. Five years later, the category for the wolves of Minnesota was changed to Threatened. In subsequent years, wolves were reintroduced to the southwest, Wyoming, Montana and Idaho, listed as Threatened experimental populations. All other wolves south of Canada are still listed as Endangered. Wolves have wandered from Minnesota and south from Canada to neighboring Wisconsin and Michigan, with about 50 wolves living in each state (Nowak 1999). Prior to eradication programs beginning in the 19th century, between 9,000 and 16,000 wolves were estimated to have occupied these three states (Savage 1996). Bounty programs killed 150 wolves a year in Minnesota alone between 1949 and 1954, and this state did not withdraw its bounty until 1965; Wisconsin stopped bountying wolves in 1957, and Michigan in 1960 (Savage 1996).

The wolves of Minnesota have gradually increased in range in the past 30 years, but they remain thinly distributed in the northern portion of the state. State regulations allow them to be killed if found preying on domestic livestock, with little or no proof of depredation. Minnesota has a compensation program for livestock owners but does not attempt to relocate wolves, even though depredations have occurred on only 1 percent of farms in that state (Savage 1996). In Wisconsin, large areas have been closed to Coyote hunting during the deer season, which has greatly decreased wolf mortality there, since many wolves were shot--either mistakenly or intentionally--by hunters (Savage 1996). Unlike Minnesota, Wisconsin relocates wolves found preying on livestock and compensates owners of livestock killed by wolves; Michigan's Upper Peninsula, where wolves are found, has no livestock (Savage 1996).

Although many Minnesota residents consider wolves to be threats to livestock and resent the protection they receive from the US Endangered Species Act, for others, they are a thrilling symbol of wilderness and the America that existed several hundred years ago. Ellen Hawkins and her husband Gary live in a wilderness cabin surrounded by Superior National Forest land, prime wolf country in northern Minnesota. Because they are avid wildlife watchers, they put out food for birds, foxes, Fishers, Martens and weasels, and state officials bring the couple road-killed deer which they place in a clearing 200 yards below their house for wildlife to feed on. They saw wolves very rarely and felt lucky to hear their howls or find their tracks (Hawkins 1988). One December day, they spotted a wolf feeding on a deer carcass on their property and noticed that he was wearing a radio collar, placed by the Fish and Wildlife Service to track many of Minnesota's wolves.

Their excitement at seeing the wolf, who brought "magic to the place," dimmed when they realized he was injured. He limped, holding up his right front foot, and they saw him fall in the snow (Hawkins 1988). He kept his tail down, a sign of subservience and fear, and moved stiffly and awkwardly. He spent five days feeding on the deer, lying in the snow near it, and seemed weaker each day. On the sixth day, he disappeared from the clearing, and in the middle of the night, an amazing event occurred: "We were confronted by his face pressed against our window" (Hawkins 1988). As they stood gaping at him, they heard him thump his nose on the glass, still staring at them. The wolf then went to another window, and they found themselves again eye-to-eye with him. He had climbed a snowdrift onto their greenhouse roof and now sat leaning against the window, looking back over his shoulder at them. The Hawkinses found some chicken and tossed it onto the roof next to him, while offering him a pan of gravy. The wolf looked at the food, and then at them, but did not eat.

The temperature was 25 degrees below zero F., and they decided the wolf needed warmth. Gary got a blanket and put it around the wolf, who jumped at first, and then quieted down. His passive response made them think that he should be brought indoors. They got an old quilt, and Gary picked up the sick wolf, carrying him into their living room. The wolf was somewhat dazed, but hardly moved. They called their neighbor, who came 12 miles to see the frail and sickly wolf sitting near the stove in their living room. Uninterested in food, the wolf looked about and seemed to warm up, leaning against the stove until his fur singed. They saw that he had lost part of his front foot, and they heard him wheezing as he breathed. Within minutes, his condition deteriorated, and he began pawing at his mouth. His wheezing grew into a "terrible, deep gurgling" (Hawkins 1988). Gary moved close to the wolf and began to stroke its

head. The wolf stood up with effort, but then slumped down to lie beside the stove. Gary removed the collar so that the wolf could breathe more easily, and they saw that it had a number--6530--with the address of the Fish and Wildlife Service. The wolf suddenly staggered into the middle of the room, spasmed and struggled for breath. Gradually they saw his eyes become unfocussed, and the light faded out as he died (Hawkins 1988).

They later learned that Wolf 6530 left his pack when he was nearly 2 years old and wandered for eight months before he returned to his family. He stayed with them only two months before walking 40 miles to another hunting area. Finally, fatally ill, he came to the Hawkins' house, which was 45 miles from his pack. An autopsy revealed that he had died of a fungal pneumonia, the first such case of wolf mortality. The disease may have been brought on by stress and lack of nourishment (Hawkins 1988). Although his coat was thick, he was emaciated, weighing only 55 pounds. At his age he should have weighed at least 75 pounds. He had a tear on his lower lip, had lost three pads on his right foot, and one pad was mutilated on his left foot (Hawkins 1988). A biologist with the Fish and Wildlife Service was contacted about Wolf 6530 and, in his opinion, the wolf's foot wounds were probably the result of getting caught in a fox trap and dragging the trap about until its toes rotted off (Hawkins 1988). As long as he was dragging the trap, he was unable to hunt with the pack, and this may have explained why he was forced to wander in search of carrion.

Many Minnesota wolves and those dispersing to neighboring states and southern Canada have been trapped in leghold traps. In fact, Wolf 6530's brother had been killed by a trapper in Ontario, 115 miles to the northeast, at the age of 18 months (Hawkins 1988). Wolf 6530 had suffered for many months, and his life ended prematurely. Wolves can live 10 years or more in the wild. Only because he had turned to people during his last days did his story come to light. Ellen Hawkins reflected on the extraordinary event: "We'll never know what motivated him to come our way. I can only say that I'm grateful to Wolf 6530 for sharing his last, desperate moments of life. His act gave us a sense of connection with his world that we would never have had, and our commitment to live in harmony with that world has been strengthened. We will always carry with us the vivid image of the wolf at the window" (Hawkins 1988). The dying wolf may have sensed that the Hawkinses were friends of wildlife, having seen them put out food and watch him without taking any aggressive action toward him. Because he was a highly social animal who had been forced into solitude for most of his short life, he may have sought their company, sensing that he was close to death, preferring humans to an isolated and painful death without his pack mates. Whatever his motivation, his appeal to the Hawkinses' prior to dying was evidence of the complexity of this fascinating creature, and an indictment of the continued use of the inhumane steel jaw leghold trap.

Wolves, Wild Dogs and Foxes: Page 4

To counter the strong anti-wolf prejudice, a new organization called the International Wolf Center in Ely, Minnesota, has live wolves in an enclosure, museum exhibits and field classes. The 50,000 visitors it has received in the past few years brought $3 million to the local economy (Chadwick 1998). But wolves in Minnesota and elsewhere continue to be taken in traps set for other types of animals, causing injury or death. One study on wolves taken in various types of traps was published in the *Journal of Wildlife Management* (Ballenberghe 1984). It investigated injuries and mortality of 126 wolves trapped in northeastern Minnesota and Alaska. Traps used included steel jaw leghold traps of various types, some with teeth, others with smooth offset jaws; steel cable foot snares; and cable neck snares equipped with devices that prevented the loop from fully closing (Ballenberghe 1984). The results confirmed that steel jaw leghold traps caused the greatest number of injuries and mortalities: 41 percent of 109 adults, yearlings and pups caught in these traps incurred serious foot and leg injuries, defined as lacerations, damage to tissue, bone breakage, and joint dislocations (Ballenberghe 1984). Three wolves, including a pup, had broken leg bones; two others lost front feet after they were nearly amputated by the trap. One young male with broken radius and ulna bones in his foreleg was released in this study to stumble off; this wolf was caught by a trapper several months later (Ballenberghe 1984).

Other injuries resulted when trapped animals gnawed their own feet off and chewed on the traps, breaking teeth and

splitting lips. The steel jaw leghold traps caused tissue, muscle and tendon injuries, even when checked daily (Ballenberghe 1984). Since the observations carried out were not done by a veterinarian, or with aid of X-rays and other sophisticated tools to arrive at diagnoses, many unnoticed or undetectable damage to nerves, ligaments and other body parts almost certainly went undetected. Other effects of trapping noted in his study were heat and water stress; stress from risk of discovery and killing by people happening upon them; killing by other predators finding them trapped; and undiagnosed trauma (Ballenberghe 1984). In the same study, a wolf was killed by a cable neck snare when it passed over his chest and closed around his stomach. Long-term effects from broken teeth, severed tendons and poorly healed bones made survival unlikely. This was the case with Wolf 6530, described above, who suffered for many months with an injured paw after pulling free from a leghold trap, becoming weaker and weaker until he died.

Another method tested involved darting animals with tranquilizers from helicopters, which resulted in the euthanizing of a wolf after it became paralyzed when the dart penetrated its spinal column (Ballenberghe 1984). Of the animals darted, 85 percent sustained injuries and soft tissue damage. The Ballenberghe study also cited other research projects with even higher mortalities, and commented, "None of the wolf capture methods discussed here resulted in study animals that were free of injuries, but some methods clearly had more potential to inflict serious injuries than others."

The steel jaw leghold traps that Ballenberghe found to be the most injurious are the very traps that are still used by the Fish and Wildlife Service, Animal Damage Control (ADC)*, state game departments and others, killing wolves and many non-target animals. The US Department of Agriculture's Animal Damage Control program, which traps hundreds of thousands of Coyotes, Cougars and other predators for the benefit of livestock owners, has been responsible for the incidental trapping of endangered and threatened species, from Bald Eagles (*Haliaeetus leucocephalus*) to Gray Wolves.

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*Animal Damage Control (ADC) has since been changed to fiWildlife Services.fl

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Many wolves are trapped by wire snares. A loop of wire pulls tight and cuts through the skin when the animal steps into it or, in the case of a neck snare, it is placed a few feet off the ground and strangles and cuts through the flesh of an animal blundering into it. Most US states allow wire snares, and wolves are taken in them in Alaska. The Alaska Department of Fish and Game has sponsored various control programs or "studies" on wolves, using airplanes, steel jaw leghold traps and, most often, wire snares. The avowed purpose of recent state research, which involved trapping wolves in a large wildlife management area near Fairbanks, was to determine their population and effect on ungulate prey, such as Moose, Caribou and Elk. In fact, this and similar "studies" have been launched after hunters urged the state to eliminate wolves in order to leave more prey species. The rationale of the trapping program is based on the premise that killing wolves will result in increases in the population of these prey animals. A program in the 1970s involved the elimination of wolves from a 3,000-square-mile area, but according to Warren Ballard, a retired game biologist from Alaska, the Moose population did not rebound after wolves were exterminated (Egan 1992). Moreover, it creates an imbalance in the ecosystem. Killing of ungulates by human hunters does not cull the sick and old, but rather the fittest and largest.

In 1992, such a wolf "research" program, involving the setting of thousands of wire snares, was carried out south of Fairbanks. Gordon Haber, a conservationist and wolf biologist who has worked for decades on behalf of Alaska's wolves, brought television crews to film the snaring operation in December 1994. They were shocked by the scene that awaited them. Four wolves had been caught in wire snares, two of them pups. One was dead, and three were still alive, terrified and in great pain. A 6-month-old pup, with its paw caught in a neck snare, had chewed off its foreleg in a futile effort to escape. Another had been snared around the chest, causing deep wounds. The other two had been snared by the leg. All these snares had been set to catch the wolves by the neck and kill them, yet none did. Members of the pack milled about nearby, unwilling to leave their fellows. Two snared Caribou were lying dead nearby. A trapper was filmed as he attempted to shoot the wolves, repeatedly missing or wounding them because he used the wrong caliber ammunition in his gun. He shot one pup five times in the head and body at point-blank range with the

wrong gauge ammunition. The pup, wounded, remained standing. The trapper then reloaded with other ammunition, and this time shot all three wolves fatally.

The film of this massacre was shown on national news programs, causing outrage around the country. Alaska Governor Tony Knowles called off the hunt, ordered a review and stated, "That's no way to treat an animal." Six hundred and eighty-five snares set for this program were removed from state lands, but not before 12 more wolves had been killed. More than 1,000 snares had been set by the state for this "study," which lasted two years. On February 2, 1995, Governor Knowles made public the results of the Gray Wolf kill review. During the program, 134 wolves were snared, 37 of which were found alive and had to be shot. Also caught in the neck snares were Moose, Caribou, Grizzly Bears, Wolverines, Coyotes, Red Foxes, Arctic Hares, Common Ravens and Golden Eagles (AWI 1995). This gruesome haul of non-target animals is typical of the indiscriminate nature of snares.

Governor Knowles canceled the wolf kill indefinitely and ordered a review of Alaska's entire predator-control policy. This "research" program was permanently canceled in February 1995. A biologist with the Alaska Department of Fish and Game admitted in 1997, while appraising the program, that it had been ill-conceived, poorly run and politically motivated. He insisted, however, that wolves had suffered no pain from the snaring and even from chewing off their own paws. This failure to acknowledge proven neurological effects of such injuries is not unusual among state game department officials.

In 1996, the Alaska Department of Fish and Game began a new program to curtail the wolf population in the Fortymile region near Fairbanks. This time, the program consisted of sterilizing the alpha male and female of each of the 15 wolf packs in the area, with plans to relocate all "subordinate" wolves (Trost 1998). The plan to reduce all 15 packs to a single sterile pair was intended to increase the number of Caribou for hunters (Trost 1998). The Alaska Wildlife Alliance strongly opposed this project, and Gordon Haber expressed the opinion that it would reduce the wolves of the area to the brink of extinction (Trost 1998). This research program was described as "based on assumptions" by the National Academy of Sciences.

Alaska's trapping regulations are the laxest in the country, with no visitation requirement, meaning that trappers are not required, as in most states, to check traps daily for animals. Animals suffer in steel jaw leghold traps or snares for days. One case is known of a trapped Lynx--brought food by its mate--that lived for six weeks with its leg caught in a leghold trap.

No state regulations govern the manner in which trapped animals are killed, and trappers often stomp trapped animals to death to obtain pelts without damage--such as that caused by bullet holes--to the pelt. The Alaska Game Department takes advantage of the strong ties between wolf pack mates by requiring trappers of wolves to count the number of wolves in the packs of the animals they trap. Pack mates will usually remain by their trapped pack mate, even when it is dead in a trap.

Wolves, Wild Dogs and Foxes: Page 5

Aerial hunting of wolves was carried out for decades in Alaska by private parties and the Alaska Department of Fish and Game itself. Prior to 1972, wolves could be hunted from airplanes for sport, or by state predator-control agents. Federal legislation was enacted in that year to ban such hunting, with high penalties including confiscation of aircraft, large fines and even jail terms. In fact, Director of Wildlife Conservation David Kelleyhouse, known as "Machine Gun Kelleyhouse," suggested that the best way to control wolves was to machine-gun them. In 1991, a state law was passed in Alaska that allowed shooting of wolves if the aircraft landed 330 feet away from the animals. This legislation was virtually impossible to enforce. Many hunters flew over wolf packs, hazing them until the wolves were too exhausted to escape. Then they would land and kill the wolves. The law failed to protect wolves from this type of

harassment and killing. Among the misuses alleged were trappers checking their trap lines by flying from one set to another, and killing wolves and other predators they saw. Another common practice that was targeted was the "recreational" aerial hunting of wolves. Conservationists in Alaska began a petition campaign to change the law through voter ballot referendum for the November 1996 national election, having failed to persuade the legislature to enact a stricter law. This ballot was openly opposed by many members of the Alaska Department of Fish and Game, who were then chastised for this lobbying by the Governor. The ballot was voted into law by the Alaskan public. The new law states that no one who flies an aircraft to an area and lands, may shoot a Gray Wolf, fox, Lynx or Wolverine on the ground the same day. This closed the loophole left by the previous law.

Wolf hunting is carried out by snowmobilers in many parts of Alaska. Brenda Peterson, an eyewitness to one of these hunts, described it, and photos taken of the event documented the wolves being chased into a tight group and killed (McIntyre 1995). Six black wolves, an entire family, died "splayfooted against one another," having run for their lives at a gallop of 35 miles per hour as the snowmobilers herded them into a terrified, dense mass, and then shot them at point-blank range (McIntyre 1995).

The total kill of wolves by hunters and trappers in Alaska in recent years has declined from 1,600 taken in the winter 1993 to 1994 to 1,180 taken in 1995 to 1996, according to the Alaska Department of Fish and Game. With a total wolf population in the state in late 1995 estimated at about 7,000, the kill represents 17 percent of the total population. This is probably threatening some populations. One race of Alaskan wolves, the Alexander Archipelago Wolf (*Canis lupus ligoni*), an extremely rare subspecies, resides in the heavily logged Tongass National Forest. In spite of various threats, the US Department of the Interior has refused to list the wolf on the US Endangered Species Act (see Forests chapter).

Within the past few decades, wolves have again become resident in several western states. Beginning in the 1970s, a few Gray Wolves crossed the border from Canada into Montana's Glacier National Park where a population of about 100 wolves in 10 packs now lives (Stevens 1997).

Wolves, Wild Dogs and Foxes: Page 6

In the 1990s, the Fish and Wildlife Service began a reintroduction program of wolves into Yellowstone National Park and portions of Idaho and Montana to the north. Historically, wolves were killed to the last individual in Yellowstone National Park by park service personnel under predator-control laws. Their return is a vindication of their importance in the ecosystem. From the start, the project was fraught with difficulties and controversy, with conservationists pitted against one another as to methods and regulations, and many cattle and sheep ranchers opposing the entire project, vowing to kill any wolves that strayed out of the park. Defenders of Wildlife began a fund to repay ranchers for lost livestock, which helped convince some ranchers to accept the project. Of the 14 Canadian wolves released in 1995 in Yellowstone National Park, almost all remained within the park. Two packs produced a total of nine pups, and 17 more wolves from Canada were set free in the park in 1996. The largest of the reintroduced wolves and his mate left the park, and he was gunned down by a drunken man for sport; he skinned this big male and threw the carcass into the brush. Later, the wolf's pregnant mate found the skinless carcass and dug a den beside it. The hunter who, in defiance, sported a shirt reading "Northern Rockies Wolf Reduction Project," spent six months in jail and a year of supervised probation after being found guilty of deliberately killing the wolf.

These Canadian wolves, taken from areas where they were hunted and trapped, experienced a trap- and gun-free environment in Yellowstone National Park. They have adapted well, preying mainly on Elk, which had become overpopulated. Only a few Bison have been taken. Within a few years, the wolves have had major effects on the park's ecosystem. Grizzly Bears have benefited by feeding off the remains of wolf kills, as have ravens, foxes, Bald Eagles and Golden Eagles. The park's aspen trees have also benefited. Researchers from Oregon State University determined

that until the late 1920s, young aspens were able to survive and mature within existing groves, but after the last wolves were killed off about 1926, the aspens began to die out because the overpopulated Elk browsed on these trees in the winter, stunting them. Another change that resulted from the absence of wolves was the disappearance of smaller birds, such as the Calliope Hummingbird (*Stellula calliope*) and Willow Flycatcher (*Empidonax traillii*), from brushy areas that were heavily browsed by the large populations of Elk and other ungulates. Wildlife Conservation Society (WCS) biologists have been researching the many effects of the return of wolves on the park's ecology (WCS 2000).

By 1996, three packs of wolves occupied the park, and a fourth pack of four wolves lived on the park's northwestern border. Their total population in Yellowstone has risen to about 185, exceeding the expectations of scientists (Murphy 2000). Although detractors remain, wolves have garnered a great deal of support. Scientists have come to Yellowstone National Park to study the wolves, some saying it is the best place in the world to see these animals in an open habitat, exhibiting natural behavior. Tourists, likewise, have flocked to see the Yellowstone wolves, bringing $43 million a year to the area, according to Defenders of Wildlife (Rembert and Motavalli 1998). Visitors have been thrilled to see these wolves streak across the grasslands, meet in affectionate, playful groups and raise their melodious voices in group howls. The wolves are expected to be a major tourist attraction in the future, perhaps rivaling the world-renowned geysers. Television films have been made of the wolves, chronicling their reintroduction and pack behavior, and *The Return of the Wolf to Yellowstone*, a book by Thomas McNamee (1997), recounts their reintroduction.

The wolves were released under a special designation of the US Endangered Species Act known as "non-essential, experimental populations," a category that permits authorities to kill them if they are found preying on livestock, or even if they cause adverse effects on wild ungulates such as deer and Elk. It is not legal to kill them for sport deliberately (FWS 1994). As a result, many wolves straying outside Yellowstone National Park have not fared well. One pack of 13 that roamed the plateaus north of the park declined to a single wolf in one year; all but three, who are now back in captivity, died or were shot (Murphy 2000). Several conservation organizations sued the Fish and Wildlife Service to appeal the non-essential designation, stating that there were already some wolves present that would be killed at will because of the designation. Livestock owners also sued the government, requesting that the program be stopped and the wolves be removed. These lawsuits were not heard in federal court until late 1997, after 66 wolves had been brought from Canada to Yellowstone and Idaho in 1995 and 1996.

In December 1997, the lawsuits from both sides of the wolf issue were finally heard in a US District Court, which came to the stunning decision that the Fish and Wildlife Service had violated the US Endangered Species Act by declaring the wolves an experimental population because wolves that might already be present would be denied full protection of the law. The judge ordered that the reintroduced wolves be removed from the park, but stayed his own decision pending appeal. Secretary of the Interior Bruce Babbitt expressed the Department's support for keeping the wolves in the wild. The Fish and Wildlife Service stated that should the decision be upheld on appeal, the wolves would have to be euthanized, as there was no area where they could be released (Chadwick 1998). The decision was appealed and overturned in January 2000, allowing the wolves to remain as part of Yellowstone's ecosystem for the indefinite future.

For the long-term success of the reintroduction of Gray Wolves into this region, the entire Yellowstone ecosystem, which extends well beyond the limits of the national park and other federal lands, should be protected. Already, much prime habitat that was once occupied by wildlife has been converted for agriculture, livestock and homes. Growth of housing and spread of the urban landscape in Jackson, Wyoming, are gobbling up thousands of acres each year. At least one cattle ranch has recently been purchased as a buffer for wolves and bison straying out of Yellowstone National Park. Efforts should be made to acquire more habitat so Yellowstone's wolves and those to the north could be linked through forest corridors to avoid inbreeding and provide space for expanding populations. The Greater Yellowstone Coalition has proposed a program called Y to Y, or Yellowstone to Yukon, that seeks an even more ambitious goal: to link reserves and parks between the two areas, providing a vast wildlife corridor. Much of the land in this linkage area is already federally owned. Grizzly Bears and wolves are among the many wildlife species that

require enormous amounts of habitat, and unless action is taken now, populations of these and other wide-ranging animals will become isolated and inbred.

Central Idaho has 12 million acres of national forest land and was chosen as a release site because of the enormous potential habitat. Opposition to the reintroduction in Idaho was strong, and the state legislature blocked the involvement of the state wildlife department (Robbins 1997). The Nez Perce tribe, which has a strong commitment to preserving the wolf, stepped into the void and became the first Indian tribe to manage an endangered species in an entire state (Robbins 1997). The project is headed by a tribal leader, Jaime Pinkham, a forest biologist who returned to his tribal roots and became manager of the Nez Perce Department of Natural Resources (Robbins 1997). Conservation groups, such as the Gray Wolf Education and Research Center in Idaho, are attempting to change the anti-wolf opinions of local ranchers with films, several penned wolves and other programs. Unfortunately, wolves have been released in Idaho and in Montana, where many have been shot, trapped or died from other causes. They lack the protection of a large national park where hunting and trapping are prohibited, and many ranchers graze cows and sheep in and near the national forests.

Most wolves prefer wild prey, but because of the large number of livestock in the region, the success of these releases may depend on whether the wolves can be conditioned to keep away from livestock. Several of the reintroduced wolves have killed calves in Idaho and Montana, resulting in anger from ranchers who have convinced the Governors and many state delegates to legislate against the program. Fears have even become irrational. Some ranch mothers sent letters to Idaho's Congressional delegation demanding that children be guarded from wolf attacks at school bus stops (Corbett 2000). The Republican delegation from Idaho passed a unanimous resolution at their convention, calling for the immediate removal of all reintroduced wolves (Corbett 2000). Signs urging that wolves be killed were placed in store windows in Idaho. Fish and Wildlife Service biologists killed 82 wolves during the first five years of the program, after complaints from livestock owners (Corbett 2000). Several wolves were shot under questionable circumstances. After a calf was killed, for example, the Service ordered three adult males of the pack killed from a helicopter; sharpshooters, unable to kill the adults, ended up shooting three pups (Murphy 2000). After ranchers reported that a pack had backed a group of his horses against a cliff, the alpha male was removed, leaving his mate alone and the pack without a leader (Murphy 2000).

Some environmentalists protested these killings and threatened to interfere before more wolves were shot (Corbett 2000). David Gaillard of the Predator Conservation Alliance questioned the wisdom or purpose of introducing wolves that needed to be controlled and trained (Murphy 2000). Experiments are underway using electric shock collars that shock a wolf when it comes close to a cow or calf wearing a collar that sets it off. This is a crude approach, which inflicts pain on the wolves and may not even succeed in its intent. Some humane organizations that have protested these collars have rightly stated that almost no efforts have been made to teach ranchers to protect their livestock with sheepherding dogs, pen them in at night and before calving and lambing, and use other means of preventing predation.

Wolves, Wild Dogs and Foxes: Page 7

Historically, the critically endangered Mexican Gray Wolves (*Canis lupus baileyi*) roamed montane woodlands and drylands in northwestern Mexico and extreme southern Arizona, New Mexico and Texas. After centuries of persecution, they disappeared altogether from the United States and verged on extinction in Mexico. In 1976, the subspecies was listed on the US Endangered Species Act, and in 1982, the Fish and Wildlife Service approved a recovery plan in which a professional trapper was hired to capture the last few wild wolves in Mexico. Only five of these wolves were found, and in this 11th-hour rescue, they were live-trapped in Chihuahua and Durango for captive breeding (Brown 1995). They have bred well in captivity and, in 1998, numbered 175 distributed in a number of American zoos (Bass 1998). Through genetic testing, new strains of pure Mexican Wolves have been identified in

Mexican Wolves already in captivity; this adds to the subspecies™ known diversity (Brown 1995). Smaller than northern wolves, males weigh 60 to 70 pounds and females 50 to 60 pounds.

The recovery plan's major goal was to reintroduce Mexican Gray Wolves into portions of their original range in a joint project by the Fish and Wildlife Service, the ADC program which had been responsible for their demise, the US Army, and the state wildlife departments of Arizona and New Mexico (Brown 1995). Surveys conducted in the region determined that most people favored the reintroductions (Brown 1995). Ted Turner, the founder of Cable News Network (CNN) and other cable stations, is New Mexico's largest landowner with more than 1 million acres. He offered one of his ranches, Ladder Ranch, which is near the Blue Range mountains release site, as a holding area and paid an employee to oversee construction of holding pens (Bass 1998). This was supported by his organization, the Turner Endangered Species Fund (Bass 1998).

Although the public as a whole supported the wolf reintroduction, many New Mexican ranchers expressed great antipathy. The national forest release sites allow hunting and trapping. Many volunteers and a grassroots organization, Preserve Arizona's Wolves (PAWS), have worked for decades to bring about this reintroduction and volunteered their time to help on Ted Turner's ranch preparing for the arrival of wolves from two zoos (Bass 1998). In December 1997, four wolves, two sisters and two brothers from separate zoos, arrived at Turner's ranch and were paired off male-and-female in separate pens, where they stayed for several months (Bass 1998). More arrived and spent time in acclimatization pens before release. The release program failed. Of 11 Mexican wolves released in the area, five died, one disappeared and is presumed dead, and five have been returned to captivity near Alpine, Arizona (Sink 1998). One pup born in the wild is missing and presumed dead, since its mother was shot in August 1998 (Sink 1998). A New Mexican rancher is said to have offered $35,000 to anyone who would kill all the wolves returned to the wild (Sink 1998).

Among the wolves that were shot was one of a newly formed--but strongly bonded--pair, Val and Minnie (Bodo 1999). Soon after release from the holding cage, Val was shot by a camper who claimed that the wolf charged at him; a necropsy revealed that the wolf had been killed standing still, broadside to the man (Bodo 1999). The female, Minnie, who had been born at the Rio Grande Zoo in Albuquerque, was pregnant with four pups when her mate was killed. She was returned to her holding pen and began to try frantically to dig and leap her way out of the pen (Bodo 1999). Her pups were born, but all died. At the end of 1998, she was shipped to the Living Desert Wildlife and Botanical Park in Palm Desert, California, where she paced or remained curled up in a spot of dirt, failing to interact with her surroundings or a male put in her pen (Bodo 1999). She was spayed and will remain in captivity for the rest of her life. As for the other deaths, no examples of livestock predation were found. About 140 of these wolves remain in captivity (Nowak 1999).

The reintroduction of Mexican Gray Wolves will be far more difficult than the Yellowstone National Park reintroduction, which involved transplant of wild Canadian wolves. These captive-born wolves have no knowledge of wild survival. They will need to learn how to hunt large prey as a pack, as well as how to survive the many threats humans pose to them. Their intelligence and instincts may be the deciding factors for their survival.

The legal status of the Gray Wolf in the lower 48 states seems destined to change in the near future. The Fish and Wildlife Service wants to change the status of the species from Endangered to Threatened in all but the southwest, where the Mexican subspecies is being reintroduced, and remove the Minnesota wolves altogether from the US Endangered Species Act (Revkin 2000). Minnesota wolves continue to be persecuted, and suffer from parasitic heartworms and deadly canine parovirus disease spread by domestic dogs (Nowak 1999). Delisting undoubtedly will unleash unrestricted hunting and trapping of these animals. Total legal control will revert to the state of Minnesota should this proposal be finalized.

The wolves in the West, from Yellowstone National Park to Idaho, Montana and Washington, would be listed as Threatened when removed from the experimental category. This category has much more flexibility concerning how much protection a species receives. Penalties are lower, and species may be hunted and trapped under the category.

Some ranchers in the West are prepared to eliminate wolves outside national parks. One rancher in Montana installed loud alarms that are triggered by the radio collars used to monitor most of the area's wolf packs (Revkin 2000).

The approximately 3,500 wolves south of Alaska, most of which are in Minnesota, occupy only about 5 percent of their original range, and as a result of prejudice and unfounded fear, these wolves are still being persecuted. Several states have enacted laws banning reintroduction of wolves, which would also apply to wolves crossing over the state's borders. Proposals to reintroduce wolves into Maine or New York have also been met with opposition by many (Higgins 2000). A major education program is needed to allay these fears and to train ranchers to protect their herds and flocks, compensating them for any losses. Although the detractors speak more loudly than the defenders of wolves, the latter probably far outnumber the former in the United States as a whole. It may fall to private conservation and humane organizations to turn the tide in favor of the wolves to return them to a greater percentage of their original range in the lower 48 states.

Wolves, Wild Dogs and Foxes: Page 8

Elsewhere, the history of the Gray Wolf is similar. As early as 300 B.C., Celtic people in the British Isles began breeding wolfhounds for chasing and killing wolves (McIntyre 1995). The King of Scots decreed in the second century B.C. that anyone killing a wolf would be rewarded with an ox (McIntyre 1995). In Anglo-Saxon England, January was designated Wolf Month, to be devoted to the slaughter of wolves; during the reign of King Edgar of England, beginning in 953, a tribute of 300 wolf skins per year was demanded. In 1281, King Edward I hired a man to devote himself entirely to killing wolves (McIntyre 1995). Over the next centuries, wolf extermination campaigns continued in the British Isles, and forests were leveled for livestock grazing and agriculture. The last wolf in Ireland was killed in 1821, and a wolf killed in Scotland in 1848 resulted in the extinction of the species throughout the British Isles (McIntyre 1995).

In France, Emperor Charlemagne founded an order of knights for killing wolves, called the Louveterie, about A.D. 800 (McIntyre 1995). Wolves were exterminated 1,000 years ago in all but remote forests of the French Pyrenees on the border with Spain. By the 20th century, only a handful of Gray Wolves survived in these forests, and apparently they were killed off in the 1950s. In the early 1990s, small numbers of Gray Wolves crossed over the Alps from Italy into southeastern France. In 1999, the French government decided to remove these 40 wolves, killing or caging them, after complaints by herdsmen that the wolves were killing sheep (Newman 1999). Environmentalists claimed the sheep were being killed by feral dogs (Newman 1999).

The last wolf in what is now Germany was killed in 1847 (McIntyre 1995). Within the past decade, a few wolves have entered eastern Germany from Poland, which has a population of about 1,000 wolves (McNamee 1997). Polish wolves have been heavily persecuted for centuries, and only in 1998 did the species receive official protection (Nowak and Myslajek 1999). They occur mainly in eastern mountains where they have come into conflict with livestock owners. An organization, Wolfnet, has been working with livestock owners to compensate them for losses and protect them against predation by wolves (Nowak and Myslajek 1999). Wolfnet travels around the country educating the public, government officials and students about the behavior, biology and intelligence of wolves, attempting to undo the mistaken beliefs that result in many killings of wolves (Nowak and Myslajek 1999).

Scandinavia has nearly wiped out its wolves, with only about 25 in Norway and Sweden and fewer than 100 in Finland (McNamee 1997). In 2001, the Norwegian government allowed the killing of some of the few remaining wolves because of complaints by livestock owners, despite protests from wildlife organizations in the country. An unknown--but small--number also survive in Greenland (McNamee 1997).

In Spain, wolves may total from 1,500 to 2,000, the largest population in Western Europe (McNamee 1997, Binder

2000). They are heavily persecuted there, however. At one time wolves were found throughout the Iberian peninsula, but they are now confined to the northern portions of Spain and Portugal (Bergman 1997). In Portugal, only about 150 survive. The wolves of Spain and Portugal are listed by the *2000 IUCN Red List of Threatened Species* as Conservation Dependent. At least half of rural people in areas where wolves remain in Iberia believe the animals should be exterminated altogether, while another 35 percent want them "controlled," allowing only a few to survive (Bergman 1997). Wolves may be sport hunted in Spain, resulting in the deaths of at least 300 animals a year; added to this mortality, the practice of denning, or killing pups in a den, is legal, and 25 percent of wolves are killed in this manner (Bergman 1997). Luis Mariano Barrientos, a biologist studying Spain's wolves, has documented that they kill relatively few sheep, which are usually protected by mastiff dogs and shepherds. He says that the wolves are killed because of prejudice and persecution, and laments, "It's a national disgrace. A barbarity" (Bergman 1997). A recent study recommended that a strict compensation program be set up. At present, indemnities are paid only if local administrations choose to do so, and many do not (Bergman 1997). This results in great resentment toward wolves. The wolves of Spain survive by stealth, hiding in fallow fields and moving about at night, and when they howl, they risk their lives (Bergman 1997). For long-term survival in Spain, they need a large sanctuary with natural prey species.

Small populations of Gray Wolves still remain in pockets of the Mediterranean region. About 500 wolves survive in Italy, listed as Vulnerable by the International Union for the Conservation of Nature (IUCN). Very little wilderness remains in the country, and wolves have been squeezed into agricultural and livestock grazing areas (McNamee 1997). Their survival until the 20th century is due to an attitude of tolerance, unlike the prejudice and hatred toward wolves so common in Europe. No national extermination campaign was ever launched, and herders corral their sheep at night and protect their flocks with guard dogs (McNamee 1997). Because of a lack of natural prey, such as deer, in the region, these wolves occasionally kill livestock. When this happens, herders put out poison or shoot the wolves. Italian wolves live in pairs or groups of three in most areas because there are no large ungulates to hunt in packs. This has made them quiet, nocturnal and shy. These wolves also prey on small mammals, such as rabbits and marmots (McNamee 1997). Only in a few national parks, such as the Abruzzi east of Rome where about 20 to 30 wolves hunt deer, do they exhibit natural behavior, forming packs and howling (McNamee 1997). Even there, however, sheep are allowed to graze within park boundaries, and sheep owners have been soliciting members of the public to "adopt" a sheep to contribute to the cooperative farm (Stanley 2000). By the 1970s, wolves numbered only a few hundred, but after the government accorded the species full protection in 1976, they began to increase in numbers and range (McNamee 1997). They now occupy the entire country, and if there are livestock losses, owners are compensated and are not allowed to kill the wolves (McNamee 1997). Professor Luigi Boitani, a wolf biologist at the University of Rome, commented at a wolf conference that most of the Italian public is in favor of wolves and more opposed to control programs than some wildlife managers, like himself (Binder 2000). The official protection given to these wolves is far stronger than that given to either the Gray or Red Wolf in the United States.

Southeastern Europe's wolf populations are fragmented, but increasing in some countries. The former Yugoslavia has about 930; Hungary, 50; Romania, which protects the species, 2,500; Bulgaria, fewer than 100; Slovakia, 350; and Greece, 300 to 500 (McNamee 1997). Romania is the only one of these countries where people have a tradition of honoring wolves; sheep in the country are protected by guard dogs, and wolves prey mainly on native ungulates. In some areas the wolves have taken to ranging through city trash piles for food (Binder 2000). Croatia allowed unlimited killing of wolves until 1995 when fines of up to $6,000 were imposed for killing wolves (Binder 2000). This had the counter-effect of encouraging wolf killing, resulting in the deaths of more than 40 wolves, and no one has paid a fine; about 100 wolves remain in the country (Binder 2000).

In the eastern Mediterranean, there are estimates of a few wolves remaining in Lebanon; about 30 in Egypt; 200 in Jordan; 150 to 300 in Israel; several thousand in Turkey; and about 1,000 in Iran (McNamee 1997). In Saudi Arabia, where wolves are killed to protect livestock, hunters often string up a wolf carcass on a pole for all to see (Binder 2000). Dr. Iyad A. Nader of the King Khalid Wildfire Research Center in Riyadh, estimated that up to 700 wolves remain in three protected areas of Saudi Arabia, but elsewhere in the country they have no legal protection (Binder 2000). Wolves are persecuted by livestock herders in all the latter countries.

Just after World War II, there were between 150,000 and 200,000 wolves in the Soviet Union, but beginning in 1947, an intensive government control program drastically reduced their numbers (Nowak 1999). The annual kill was 40,000 to 50,000 until 1962, when it dropped to 15,000; in the 1970s, some 50,000 wolves were estimated to survive in the entire country, including the Central Asian Republics (Nowak 1999). After an increase in wolf populations, a sizeable bounty was paid for killing them; and in 1980, 35,573 pelts were taken through aerial hunting, poisoning and other means (Nowak 1999). fiThe Russian Grey Wolffl (1993, Anderson Video, California) chronicled this bounty hunting and other persecution. In the past 70 years, more than 1.5 million animals have been killed; about 20,000 wolf pelts are marketed in Russia every year (Busch 1995). In the early 1990s, 17,000 men were employed by the Russian government to kill wolves. Since then, the national bounty has been rescinded, and only some state governments pay the equivalent of $25 for a female; the central government no longer encourages poisoning wolves (Binder 2000). In the Russian Far East, a bounty program to kill wolves has been in place for decades, but with the economic chaos following the fall of the Soviet Union, funds to pay the bounties dried up (Specter 1997). A 2001 Cable News Network (CNN) report profiled a government trapper who killed female wolves for the bounty, then raised the orphan cubs for release. The report suggested that persecution continued at high levels and that most Russians wanted the species exterminated.

The Wolf Almanac (Busch 1995) states that some 96 Russian wildlife reserves harbor wolves, and they are hunted actively in 41 of these. They are reported to be safest in certain large reserves, such as the Caucasian, Altai and Pechyora-Ilych reserves, unless they stray outside to prey on livestock (Busch 1995). Wrangel Island in the Arctic Ocean is to be made into a nature preserve with a wolf colony to cull the large herds of Musk Oxen and Caribou (Binder 2000).

Japan's wolves were killed off 100 years ago, and public opinion is negative about their reintroduction. Biologists want them reintroduced to control Japan's overpopulated Sika Deer, which are damaging forests (Binder 2000).

In Kazakhstan and Central Asia, wolves and Saiga antelope have coexisted for eons, but during this century, both have come under heavy hunting. A film, fiThe Saiga of Kazakhstanfl (see Video Section), describes the detrimental effect that wolf control programs have had on Saiga. Wolves are estimated to number between 90,000 and 100,000 in the country, but biologists claim that they kill large numbers of domestic camels, cows and sheep (Binder 2000). Killing wolves is considered a sport in Kyrgyzstan, south of Kazakhstan, where Golden Eagles are used as falconry birds to hunt foxes, badgers, Lynx and wolves (Kinzer 1999).

Mongolia has an estimated 10,000 wolves; China only about 400; and Afghanistan, 1,000 (McNamee 1997). In Tibet, wolves are heavily persecuted by livestock owners, and in the vast Chang Tang Reserve, it is the only species without legal protection. Wolf carcasses can be seen lying next to roads, the animals having been shot by hunters in vehicles, and biologist George Schaller (1998) saw three wolf bodies in a village dump with their jaws wired shut.

India has fewer than 1,000 wolves by some estimates (McNamee 1997), and between 800 and 2,000 in the opinion of Dr. Yadvendradev Jhala of the Wildlife Institute of India. The species is held in great fear by many Indian people, who regard wolves as man-eaters. A century ago, a bounty program resulted in the slaying of 2,600 wolves (Burns 1996). Indian Gray Wolves (*Canis lupus pallipes*) were finally accorded official protection in India in 1992. Rudyard Kipling's *The Jungle Book* tells the story of Mowgli, an Indian orphan raised by wolves. This story may have a basis in fact because many unwanted children are abandoned and placed in the woods, according to *The Wolf Almanac*, and Indian folklore recounts many cases of small children raised by wild wolves (Busch 1995). Such a child was discovered in 1972 at the age of four, apparently having been adopted by a pack of wolves. He was placed in Mother Theresa's refuge for orphans in Lucknow, where he died after seven years (Busch 1995). In spite of such true stories, the average Indian has little but fear and loathing for wolves.

Working to help India's wolves, Dr. Jhala and the Wildlife Institute of India are conducting surveys and appraising their status. For centuries, these wolves have lost habitat and prey species to the country's growing human population. When wolves turned to livestock, persecution followed. Dr. Jhala admits, "It is extremely difficult to conserve a

species when the majority of the human population is opposed to its survival" (*Earthwatch* 1996). Beginning in 1988, Dr. Jhala conducted the first-ever ecological study of Indian wolves for his doctorate at Virginia Polytechnic Institute, with funding from the National Geographic Society and the Smithsonian Institution (*Earthwatch*, 1996). Earthwatch contributed to this research in 1996 with its volunteer program of paying participants in Dr. Jhala's studies. These volunteers followed radio-tracked wolves in the 3,400-hectare (8,401-acre) Velavadar National Park of western India, one of the wolf's last strongholds, observed Blackbuck (*Antilope cervicapra*), Nilgai (*Boselaphus tragocamelus*) and other rare wildlife, and interviewed local farmers through interpreters about their opinions of this species.

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Official protection from hunting and trapping has been accorded very few wolf populations in the world, even where they are on the verge of extinction. In some areas, however, attitudes are changing, most dramatically in the United States, where documentary films and books on their behavior and importance in ecosystems, as well as recordings of their howls can now be seen in bookstores throughout the country. Superb photography illustrates some of these, most notably *White Wolf: Living with an Arctic Legend* (Brandenburg 1992), which provides glimpses into the lives of these fascinating canids in the Canadian north. Reintroductions of wolves into portions of their former range in the American West bode well for their future, unless the prejudices of many livestock ranchers hold sway. Canada may have the largest population of wolves in the world, estimated at between 30,000 and 60,000, with about 4,000 killed for fur each year (Nowak 1999). According to genetic studies, the wolves of southern Ontario and southern Quebec have apparently hybridized with Coyotes, as have wolves in neighboring Minnesota and Isle Royale, Michigan (Nowak 1999).

The ecotourism potential for wolf viewing in many parts of the world is considerable. In Ontario, Canada, visitors to Algonquin Provincial Park have come to hear packs howl since the 1960s. One of the first wolf conservationists, Canadian wolf biologist Dr. Douglas Pimlott, initiated these tours and educated thousands of people about the biology, importance to ecosystems and behavior of wolves. Their value in attracting tourists and contributing to healthy ecosystems far exceeds that of their pelts.

For some other species of wild dogs, attitude changes may not be enough to save them. The Dhole or Asiatic Wild Dog (*Cuon alpinus*), a small canid the size of a Coyote, is native to Asia, from southern Siberia and Central Asia east to India and Indonesia (Nowak 1999). This wild dog has rusty red fur on its upper parts, and white on its chest and belly. Hunting in large packs, Dholes pursue large prey, such as deer, wild pigs, antelope and wild sheep (Nowak 1999). Their social structure is not well known but appears similar to the Gray Wolf's, with a leader and lower-ranking members of the pack (Nowak 1999). Although Dholes seldom take livestock, they have been poisoned intensively and hunted throughout their range; they are also persecuted by hunters who regard them as competitors for game species (Nowak 1999). Dholes have disappeared from much of their habitat, and the *2000 IUCN Red List of Threatened Species* lists the species as Vulnerable, the category below Endangered, indicating a serious decline.

Similar in appearance, the Simien or Ethiopian Wolf (*Canis simensis*) is endemic to Ethiopia. Scientists were unsure in the past whether this animal was a dog, a wolf, a jackal or a fox. Most zoologists now describe it as a wolf. It may be related to the small race of Gray Wolf, *Canis lupus arabs*, that inhabits the Arabian Peninsula across the Red Sea (Nowak 1999). Simien Wolves have a head and body length of about 3 feet, are about 2 feet tall at the shoulder, and weigh from 11 to 19 kilograms (Nowak 1999).

The only wolf not preying on animals larger than itself, such as deer, but living in packs, Ethiopian Wolves feed mainly on small rodents (Gottelli and Sillero-Zubiri 1994). Once their range was far greater, encompassing most of Ethiopia's highlands, but with the development of agriculture and spread of livestock grazing, these wolves lost the majority of their habitat and came under totally unmerited persecution as a threat to domestic animals (Nowak 1999).

Today, they have become restricted to only about six locations in the Ethiopian highlands. Discovered in the Simien Mountains of the northwest, the subspecies, *Canis simensis simensis*, was estimated at only about 40 animals in the 1980s. These wolves are so shy that even in the Simien Mountains National Park they have become nocturnal and stay in burrows when humans are in the vicinity. A crew from Survival Anglia, a British nature film company, spent weeks in the early 1990s seeking to photograph the Simien Wolves in this park, finally having to settle for a long-distance view of a solitary wolf.

Wolves of the Bale Mountains, separated by hundreds of miles, are larger and redder than the Simien Mountains race, and this subspecies, *Canis simensis citernii*, is somewhat more numerous than the other race. Only about 440 Simien Wolves were thought to survive in the Bale Mountains in the early 1990s, with perhaps another 100 in the Simien Mountains (Gottelli and Sillero-Zubiri 1994). Today, estimates are even lower. The Bale Mountains population is estimated at 270 to 370 animals, and 70 to 150 survive in the Simien Mountains (Nowak 1999). This species is thus at the edge of extinction. It is listed as Critical in the *2000 IUCN Red List of Threatened Species*, protected by law in Ethiopia and listed as Endangered on the US Endangered Species Act.

The Wildlife Conservation Society (formerly the New York Zoological Society) has funded research projects on the Simien Wolf for many years, including the studies of two zoologists, Dada Gottelli and Claudio Sillero-Zubiri in Bale National Park. Simien Wolves use their long legs to dig into rodent tunnels, aided by their acute senses of hearing and smell. In Bale Mountains National Park, 14 rodent species are native and three dominant species are endemic to the region, providing a huge food base for the wolves. They specialize in preying on the endemic Ethiopian Mole Rat (*Tachyoryctes macrocephalus*). The mazes of tunnels that these rats excavate aerate the soil, creating rich topsoil which nourishes the lush grasses in this highland ecosystem. The wolves have been seen hunting cooperatively, chasing young antelope and hares (Nowak 1999).

Livestock grazing is allowed in Bale Mountains National Park, and Simien Wolves wander among the cattle, presenting no threat. The wolves in this park have not been persecuted, unlike those elsewhere in Ethiopia, and do not hide from people. Filmmakers shooting the 1990 BBC film, fiKing Solomon's Mountains,fl found the wolves in the open during the day, with adults hunting rodents, and pups playing wrestling games. Like other wolves, they are extremely affectionate with one another and yip in group choruses, sounding like Coyotes. Packs range in size from five to 13 animals, and they defend territories. As in Gray Wolf packs, only one female in the pack breeds, and because of limited habitat, nonbreeding females often stay with the pack, acting as "aunts" instead of leaving to begin their own packs (Gottelli and Sillero-Zubiri 1994).

Domestic dogs, brought into Bale Mountains National Park by the Oromo people to protect their flocks of sheep and cattle from hyenas, are a major threat to this species (Gottelli and Sillero-Zubiri 1994). Wolves have succumbed to diseases introduced by these dogs, which are not fed but set free to fend for themselves. Between 1992 and 1995, the Bale Mountains wolves were decimated by an outbreak of canine distemper acquired from these dogs, reducing the wolves from 240 to 140 (Anon. 1996). In the mid-1990s, more died of rabies. An even more ominous threat is their interbreeding with domestic dogs. The film fiKing Solomon's Mountainsfl showed a pack of wild Simien Wolves led by a large black dog that had become the lead female. Another film, fiLast Wolves of Ethiopia,fl shown on a National Geographic Explorer program in early 1998, recounted the story of a young female Simien Wolf who was ousted from her pack and, after a few years of wandering, paired with a hybrid wolf-dog. In general, male domestic dogs have bred with female wolves, diluting the genetic integrity of this highly endangered animal (Gottelli and Sillero-Zubiri 1994). Some populations of pure Simien Wolves are showing signs of inbreeding, due to their small genetic base. The combination of these threats has led scientists to predict imminent extinction for this beautiful wild dog.

To prevent their extinction, attempts are being made to convince the Oromo tribespeople to control their dogs, but scientists have concluded that captive-breeding may be the only way to save the species (Gottelli and Sillero-Zubiri 1994). There is no possibility of preventing these people from entering the park because of the tribe's centuries-old ties with this region and the potential of bad relations with them that could have serious repercussions on the conservation of park wildlife (Gottelli and Sillero-Zubiri 1994). As a means of controlling the domestic dogs, they could be

neutered, vaccinated against disease, and provided supplemental food to prevent their attacking native ungulates in the park. A vaccination program has recently been carried out in the Serengeti, where domestic dogs transmitted canine distemper that killed one-third of the Lions in the region.

The South American Maned Wolf (*Chrysocyon brachyurus*) has also declined, although not as drastically as the Ethiopian Wolf. This long-legged wolf, weighing only about 44 pounds, hunts in the tall grasses of pampas and llanos, and eats rodents and other small mammals, birds, reptiles, insects, fruit and other vegetation (Nowak 1999). With shaggy red fur and black legs, it has been called a Red Fox on stilts. It is the sole member of its genus and the only wolf in Latin America. The Falkland Island Wolf (*Dusicyon australis*), native to the Falkland Islands off Argentina, became extinct in 1876 after large numbers were killed by fur traders and poisoned by sheep ranchers (Allen 1942). The size of a large Coyote, it may have evolved from foxes. Maned Wolves have been falsely accused of killing livestock, and persecution has caused them to disappear from Uruguay and most of Argentina. They have become rare in Brazil and the rest of their range in south-central South America. The Maned Wolf is listed on the US Endangered Species Act as Endangered and on the *2000 IUCN Red List of Threatened Species* as Near-threatened.

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Small predators also underwent persecution in North America in the late 19th and early 20th centuries. Two tiny western foxes that were once considered to be the same species, the Swift Fox (*Vulpes velox*), native to shortgrass prairie, and the Kit Fox (*Vulpes macrotis*) of intermountain and desert grasslands further west, both declined as a result of predator-control programs. Both are shades of tawny, reddish-brown and tan, stand about 1 foot tall, measure 23 to 31 inches long, and weigh less than 5 pounds (Nowak 1999). Although not considered threats to cows or sheep, foxes traditionally have been killed because of their possible threat to poultry. In wilderness areas, they have been killed merely because of predator prejudice. These foxes subsist on small rodents and even insects, such as grasshoppers, and are, therefore, beneficial.

The Swift Fox was named for its speed when streaking across the prairie, clocked at about 25 miles per hour (Turbak 1993). The Canadian populations of the Northern Swift Fox (*Vulpes velox hebes*), native to southern Saskatchewan, Alberta and Manitoba, and the northern edge of the shortgrass prairie that once stretched to Texas, are listed as Endangered on the US Endangered Species Act but are extinct. They disappeared from the wild by the 1930s, after control programs were implemented, and Canadian wildlife authorities have reintroduced Swift Foxes of a related subspecies from Colorado, Wyoming and South Dakota (Nowak 1999). Some reproduction has taken place.

Swift and Kit Foxes began to decline in the 19th century, and Ernest Thompson Seton commented on the vulnerability of this species: "Harmless to man and mankind's interests; and yet he is going fast with all the other innocent and lovely wild things. Yes, faster than most, for he is the least cunning of our foxes--so guileless that he readily takes the poisoned baits used nowadays for killing coyotes" (Seton 1899). In fact, almost none of these foxes was seen in the wild from the early 1920s to the late 1950s, a period of heavy predator-control and poison campaigns (Chambers 1978). Both species have lost the majority of their habitats to agriculture. In North Dakota, the state lists the Swift Fox as an endangered species, with no breeding populations. The last known occurrence of the Swift Fox in this state was in the mid-1980s (Turbak 1993). Further south, this species is known to survive in southwestern Kansas, Nebraska, Montana, Wyoming and South Dakota (Chambers 1978). Some areas of unplowed prairie provide refuge. This fox has been able to colonize on roadsides next to fields and in the few remaining unpoisoned prairie dog towns. Some research has been carried out on the wild behavior and habitat needs of Swift Foxes in the Midwest, and there is room for cautious optimism that increased attention to this little fox will result in strong legislation to preserve it and prevent persecution and poisoning. Author Glenn Chambers was researching an article for *Audubon* magazine, "Little Fox on the Prairie" when he saw a fox family being killed by two farmers who poured gasoline in the den entrance and set fire to it. The male fox, provider of food for the vixen and pups, was found in a ditch a few yards away, his rib

cage ripped out by a high-velocity bullet (Chambers 1978). The vixen had escaped the burning den with two of the pups, but the farmers shot her as she watched over them (Chambers 1978).

Kit Foxes occupy deserts, dry grasslands, and montane areas with scattered trees from Utah north to Washington state and west to California. They prey mainly on kangaroo rats and other small rodents. A subspecies from southern California known as the San Joaquin Kit Fox (*Vulpes macrotis mutica*) is listed on the US Endangered Species Act as Endangered. Settlement and farming of the region reduced their habitat, and predator control has eliminated entire populations, causing them to dwindle to a few thousand animals. This delicate, little buffy-yellow fox is now restricted to a tiny remnant of its once immense habitat of mixed grasslands, deserts and shrub in California. Their original range stretched from San Joaquin and Stanislaus counties in the north to Kern County in the south. They probably numbered at least 12,000 prior to settlement (Turbak 1993). Tame and trusting, they became targets for hunters; even schoolboys with rifles have been seen shooting them as sport (Turbak 1993). One hunter was seen shooting a pair's tiny cubs one after another as they played at the den entrance, then killing the mother when she emerged to protect them (Turbak 1993).

Foxes have been considered threats to livestock and domestic poultry by European settlers. The Cape Fox (*Vulpes chama*) of dry country in southern Africa was the object of control programs by European settlers under the misapprehension that it preyed on domestic poultry. This resulted in declines in the numbers and range of this small, silvery-gray fox (Nowak 1999). The Hoary Fox (*Lycalopex vetulus*) of south-central Brazil, an endemic species of savannah grasslands, is persecuted by local people for presumed predation on domestic fowl (Nowak 1999). Although very shy, it courageously defends itself and its young when threatened (Nowak 1999). Little is known of its status, listed as Data Deficient by the IUCN. Argentine Gray Foxes (*Dusicyon griseus*), native to Patagonian grasslands, have been poisoned by livestock owners who distribute strychnine bait. Their populations have declined in many areas as a result, and thousands of non-target mammals and birds have died from these poisons. Such poisoning is illegal in Argentina, and efforts are being made by biologists and conservationists to stop this senseless killing.

Eight species of foxes are listed as Data Deficient by the *2000 IUCN Red List of Threatened Species*, and two species as Conservation Dependent. This is an indication of the lack of research on these ecologically important species, which perform the important role of consuming large numbers of rodents. Red Foxes (*Vulpes vulpes*), native to North America, Eurasia and northern Africa, have been persecuted as well, hunted as sport in England and parts of the United States, and killed by many farmers and livestock owners. One Midwestern town even rounded up these foxes once a year and beat them to death with sticks. After a *Life* magazine article describing this cruel persecution and the resulting public outcry, it ended. Fox hunting in England may end in the near future as the Parliament has voted to stop this cruel activity.

Bears

The immense Grizzly or Brown Bear, which once roamed the prairies and woodlands of western North America, inspired awe and fear in explorers and settlers alike. For thousands of years, Native Americans revered this bear. The Cree called it a four-legged human, and other tribes considered it a brother or cousin. They felt a kinship based on its intelligence and respected its great strength. They could not easily hunt it with bows and arrows, and when wounded, it showed great courage defending itself, able to cause severe injuries or death with its 5-inch claws.

The Grizzly reigned as the fearsome and unchallenged king of all wildlife on the continent, numbering at least 100,000 prior to the arrival of Europeans (Nowak 1999). These extremely adaptable bears lived in every western North American habitat except deserts. Arriving from Asia by way of the Bering Strait 12,000 years ago when sea levels were lower, Grizzlies gradually colonized western regions, the biggest of an array of large carnivores that inhabited the continent at that time, including dire wolves, hyenas and sabre-toothed cats. They survived the frigid and

harsh climate of the Pleistocene Ice Age. They thrived in prairies, especially those with scattered woodlands. In the 1500s, their range extended from the Arctic tundra south through the shortgrass prairie to the pine forests of northern Mexico, and west to the Pacific Ocean. In fact, the original range of the Grizzly Bear may have been larger than previously thought, reaching east to the Atlantic in Canada. A Grizzly skull has been found in a midden of the late 18th century, and pelts of these bears reportedly were taken in Labrador as late as 1927 (Nowak 1999).

Grizzly Bears of North America and Brown Bears of Eurasia were previously considered separate species, but today they are classified as a single one, *Ursus arctos*. The bears that live along the southern Alaskan coast and offshore islands, such as the Kodiak, are the world's largest carnivores (Nowak 1999). Weighing up to 780 kilograms (1,716 pounds), Kodiak Grizzlies have a shoulder height up to 1,500 millimeters (58.5 inches, or almost 5 feet), and a body length ranging up to 2,800 millimeters (109.2 inches, or 9 feet) (Nowak 1999). Standing height can be almost 12 feet. Adult males are larger than adult females. North American Grizzlies are far larger than bears of the same species native to southern Europe, which average only 70 kilograms (154 pounds) (Nowak 1999). Grizzlies of the northern portion of the lower 48 states are only somewhat smaller than the Alaskan bears, while those native to Arizona, New Mexico and Mexico, all now extinct, were smaller still, weighing less than 1,000 pounds.

Reproducing at a very slow rate, Brown Bear females have an average of two cubs only once every two to four years, and the cubs stay with their mother for this entire period (Nowak 1999). On occasion, only one cub is born, and sometimes up to four. If the mother is killed at any time before the cubs leave to be on their own, the cubs will also die because they are unable to fend for themselves, destroying two generations. The training period of these bears is extremely long, an indication of their slow maturation and the complexity of learning about food sources and other keys to survival. Another reason for this long apprenticeship is the potential of attacks by male Grizzly Bears. Until a young bear is 3 years old or older, it is not large enough to withstand an attack by an adult male, requiring the protection of its mother. Males continue to grow until they are 10 to 11 years old, and may provoke fights with younger bears to chase them from the territory, which prevents inbreeding. Females remain fertile until well into their 20s. Females in the Yellowstone region are known to live to be 25 years old, and Grizzly Bears may have the potential to live 50 years in captivity (Nowak 1999). They do not reach sexual maturity until they are at least 4 to 6 years old. These bears have a low natural death rate, and when combined with their slow reproduction, they are very vulnerable to extinction should they suffer high mortality.

A large habitat requirement is another aspect of their vulnerability. In the Arctic, a single Grizzly requires more than 100 square miles of tundra, and in the Yellowstone area, each bear occupies about 88 square kilometers (Nowak 1999). In regions where they are distributed sparsely, they can be eliminated easily, and even where they are more numerous, persecution and trophy hunting have caused local extinctions.

The strength, intelligence and size of the Grizzly, which have served it so well for thousands of years, were no match for European guns. Explorers, trappers and, later, settlers, slaughtered thousands of Grizzlies, killing them on sight. The first to disappear were the bears of the Great Plains, where the landscape was open and provided little cover. In some cases, these bears showed almost mythic strength upon being shot. Meriwether Lewis of the Lewis and Clark expedition of 1804 reported that one wounded bear ran at a fast clip for nearly a quarter of a mile before it fell dead after being shot through the heart (Peck 1990). Persecution of bears often includes the killing of their cubs. Early in the 20th century, President Theodore Roosevelt refused to kill bear cubs pointed out by his hunting guide, and when this was publicized in newspapers, he became a folk hero as a result. Toy manufacturers took advantage of the story by producing stuffed animal "Teddy Bears," which remain popular today. President Theodore Roosevelt left a legacy of destructive trophy hunting, however, including the killing of many adult bears.

Settlers moving into the West hunted these bears, and during the late 19th and early 20th centuries, government predator-control agents began campaigns to eliminate these bears. Much of the zeal with which the bears were slaughtered was based on a misconception: they were thought to be vicious man-eaters. In fact, they are mainly vegetarian and only occasionally kill animals for meat. The most common animals killed by Grizzly Bears are various types of rodents, such as ground squirrels and, in some areas, fish. Elk calves are killed as part of their diet in some

areas. The staple foods of the Grizzly diet are green shoots, sedges, clover and lilies early in the spring and, later in the summer, berries, roots, fruit, acorns and nuts, with occasional rodents (Peacock 1996). These bears do not consider humans to be natural prey, and attacks are rare. Prejudices dominated, however, and hunters who killed them were considered heroes and rewarded with bounty money. To protect their livestock, ranchers insisted that government hunters kill off every Grizzly Bear, and after several centuries of uncontrolled hunting, trapping and poisoning, the bears became extinct in their vast original realm south of Canada except for a few hundred animals protected in Yellowstone and Glacier National Parks.

All 26 subspecies of Grizzly Bears south of Canada and Alaska, except *Ursus arctos horribilis*, became extinct by the 1950s, and some disappeared during the 19th century. The latter subspecies, named from specimens obtained in northeastern Montana, barely survived. In fact, *Ursus horribilis* was the species' scientific name until recently, an indication of the prejudice against it. Now considered a subspecies, *Ursus arctos horribilis* is listed on the US Endangered Species Act as Threatened, and this subspecies is used to indicate all Brown Bears in the lower 48 states.

Grizzly populations still occupy only 1 percent of their original range in the lower 48 states and number fewer than 1,000 (Nowak 1999). This includes Yellowstone and Glacier National Parks, whose protection prevented their total extinction south of Canada, a few wilderness areas in Idaho, western Montana, and Washington. Human activities such as road building disturb them and cause them to desert otherwise prime habitat. They are no longer the fearless animals that Lewis and Clark encountered, but have become very shy outside of national parks after centuries of persecution. Although they may pose a potential threat to humans who enter their last retreats, people are a far greater threat to them.

Their rugged wilderness habitat in Montana is being developed rapidly, and Grizzly populations, which had risen somewhat after their listing on the US Endangered Species Act, are now in danger of disappearing again. Added to this, some ranchers in the region still persecute them. A prime habitat for Grizzly Bears, the 329,000-acre Swan Valley of northwestern Montana borders the Bob Marshall Wilderness area, a country of open grassland and forest with breathtaking mountain views. Until recently, this landscape remained almost unchanged from its original state. Ranching, road building and other activities, and an increasing human population in this region, however, are now ruining its wilderness character and threatening the Grizzlies (Pelletier and Servheen 1995). Through cooperation with local residents, the Fish and Wildlife Service is identifying important habitat areas and linkage corridors for the Grizzly Bears in this part of Montana to prevent conflict with humans. These zones would be a link between the small population of bears in the Mission Mountains to the west and those in the Bob Marshall Wilderness area (Pelletier and Servheen 1995). The land is a checkerboard of ownership by private individuals, state, federal and corporate entities; in an unusual project, all private and public lands will be included in a management plan, with input by local citizens (Pelletier and Servheen 1995). These bears remain under the continual threat of being shot by ranchers fearful for their livestock and apprehensive about possible land restrictions in areas where Grizzly Bears are resident. Sport hunting of this small population is also allowed.

Grizzly Bears are still depicted in the media as dangerous man-eaters, resulting in a prejudiced view by the American public. A number of television programs produced by the National Geographic Society, CBS, the Discovery Channel, Fox and others have perpetuated this image. With titles such as "Dangerous to Man!," "Bear Attacks" and "Man-eaters," these programs often demonize the bears and interview people who have been attacked while camping in the bears™ habitat. Very few such attacks have occurred, and almost none has been fatal. After centuries of being shot at and harassed by humans, Grizzly Bears tend to avoid people. When camping inside national parks where Grizzlies are resident, special precautions must be taken, and it should be kept in mind that the parks are *their* home, and humans are the intruders. The national parks, where hunting is banned, are their only refuge. Some documented cases of attacks have occurred when a mother bear felt her cubs were threatened by humans, especially if they approached the cubs. Mother Grizzlies may be the fiercest protectors of their young in the animal world, a trait that should be admired from a distance. Television programs that sensationalize the potential threat of animals do not note the hundreds of Grizzly Bears killed by humans every year in North America. They also fail to show the many bears that are merely wounded by hunters and suffer a long death, or the cubs that are orphaned and die of starvation.

The irrational fear and hatred aroused by misinformation often result in mortalities to these bears by armed tourists and residents in their range who misinterpret the bears' behavior. Many bears have had to be destroyed because tourists fed them, and they became fearless, capable of swiping food or destroying tents and property. Information on avoiding Grizzly Bear encounters is available from National Park Service rangers, other federally employed biologists, and many conservation and humane organizations. Only with tolerance, respect and an informed public concerned about preserving these bears can they survive.

Ecotourism in the threatened and unprotected portions of the Grizzlies™ range is in the early stages of development. Portions of the revenues from tours could be spent to acquire habitat and conduct local education programs. In Alaska, this has been highly successful, with tourists coming from around the world to see these bears fishing for salmon. Montana has some of the most spectacular scenery on the continent, sweeping vistas and vast open spaces that rival those of East Africa. They could be a magnet for tourists anxious to see Grizzly Bears and other native wildlife against a background of snow-capped peaks. Unfortunately, much of their prime valley habitats have been taken over by ranchers and private homes. The tourism in the area has been of a highly commercial and exploitative nature. For example, in some Montana towns, tourists see many stuffed Grizzlies in local businesses, and one can have one's photograph taken posed in a cutout painting of a Grizzly Bear appearing to attack.

If sizeable portions of Montana valley habitats were acquired for the Grizzly Bears, tourists could be taken on van tours, similar to those that now operate in East Africa. For the more athletic, groups of tourists could be taken on guided walks into the high country. Portions of the funds from the tours could be used to purchase privately owned land, to fund public education about these bears and their survival, and to compensate ranchers for livestock losses. The Nez Perce tribe is working with the Fish and Wildlife Service on a project to reintroduce the Grizzly Bear into the Selway Bitterroot wilderness of Idaho and Montana, another magnificent area for ecotourism (Robbins 1997).

Plans to reintroduce Grizzlies into the 1.9 million-acre San Juan National Forest in southwestern Colorado have sparked controversy and prejudice (Papich 2000). Decades after Grizzlies disappeared from the state, the Fish and Wildlife Service reintroduction project has been applauded by local conservation organizations, such as the Colorado Grizzly Project, and opposed by ranchers and even hiking groups who fear attacks (Papich 2000). Returning the Grizzly Bear to portions of its former range in the lower 48 states, even into immense wilderness areas, will be a slow process, possible only after extensive education and a change in the accepted practice of releasing livestock in national forests without sheepdogs, herders or other protections.

The Mexican Grizzly (*Ursus arctos nelsoni*) persisted in the remote mountains of northern Mexico until it was poisoned, shot and trapped to extinction in the late 1960s (Day 1981). This race was smaller than northern Grizzlies, weighing about 700 pounds. Quite numerous and widespread, the Mexican Grizzly had an enormous range in the pine forests of the northeast until efforts began to exterminate it. Only about 30 animals remained by 1960. Although some individuals tried to protect these last bears, others set out to destroy them, and a campaign of poisoning, trapping and hunting, sponsored by ranchers, resulted in the killing of the last animal in the early 1960s (Day 1981). In 1968, biologist Carl Koford conducted a three-month survey in the isolated mountain canyons of Chihuahua where they had last been seen, and he saw no sign of Grizzly Bears (Day 1981). Subsequently, they were declared extinct.

Hunters in many parts of the Grizzly Bear's range in Canada kill the species in such numbers that many biologists consider it to be threatened there. The Canadian Broadcasting Company's "Nature of Things" program produced a film, fiGrizzlies: Losing Ground,fl which painted a dim picture of this bear's future in Canada. They are killed by ranchers and hunted for trophies and for their gallbladders, which are used in Traditional Medicine. Many are killed by park rangers merely because they come too close to tourists. They are being driven from their wilderness homes by unrestricted logging and mining as well.

Brown Bears are already extinct in North Africa, Austria, Belgium, Denmark, Germany, Israel, Jordan, Lebanon, Liechtenstein, Luxembourg, the Netherlands, Portugal, Switzerland, Syria and the United Kingdom. They are

endangered in the few countries where they remain in Western Europe. In Scandinavia, there may be as many as 700 Brown Bears, with populations of less than 1,000 in Slovia, Romania and Bulgaria, and possibly 2,000 in the former Yugoslavia (Nowak 1999). Fewer than a dozen Brown Bears survive in France's Pyrenees Mountains where, despite protests from around the world, a major highway was built through the center of their habitat. Brown Bears are heavily persecuted throughout Eurasia for body parts, especially gallbladders. They are considered endangered in Central Asia's mountains where *Ursus arctos isabellinus* occurs, a CITES Appendix I race, and the Tibetan Brown Bear (*U.a. pruinosus*) is listed as Endangered on the US Endangered Species Act. Outside Russia, only about 4,500 to 7,600 of these bears remain in China, and isolated populations survive in Mongolia, northern Japan and Turkey (Nowak 1999).

The South American Spectacled Bear (*Tremarctos ornatus*) is classified as Vulnerable by the IUCN, with persecution by ranchers a major cause (Nowak 1999). These 300-pound black bears have large circles of white fur around the eyes and white circular markings on the neck and chest. They feed on fruit, bamboo hearts, corn, and other vegetation with about 4 percent of their diet composed of rodents and insects (Nowak 1999). Spectacled Bears are native to the Andes of western Venezuela, Colombia, Ecuador, Peru and western Bolivia. This high-altitude, shy bear is active mainly at dusk and at night and poses no threat to livestock, yet ranchers and landowners have persecuted and hunted it in Peru and other countries because of the mistaken belief that it kills livestock (Nowak 1999).

With the destruction of their high-altitude, humid forest and grasslands replaced in many areas by agriculture, some bears have raided corn fields to survive; many of these bears have been shot by farmers (Nowak 1999). This bear is declining throughout its range, and few areas remain where it can forage without being hunted, either by livestock ranchers, farmers, or for its body parts to sell to Asian markets for traditional medicine. Only a few national parks exist within its range, and populations have become fragmented and isolated from one another. A biological study of these bears in Bolivia by British zoologist Susanna Paisley is uncovering new information about their natural history and the threats posed by radio-tracking. A film about her study and the local people helping her, fiBears of the High Andes,fl was shown on a National Geographic Explorer television program in 1998, providing a unique glimpse into the lives of these rare bears.

Otters

The Eurasian or Common Otter (*Lutra lutra*) has been persecuted since the 13th century in Britain, and a dog, the Otter Hound, was bred to hunt it (Chanin 1985). This otter was officially designated as a pest by a 1566 English law, which authorized local constables to offer bounties for their destruction because of their supposed predation on fish (Chanin 1985). At that time, fish ponds on the estates of the wealthy were stocked to supply the tables of the affluent (Chanin 1985). They were also thought to be competitors with fishermen for game fish such as trout. For hundreds of years, high bounties were paid, contributing to their disappearance from many areas (Chanin 1985). Hunting otters with dogs was the only effective manner of pursuit, and in the 16th century, the Assembly of Norwich decreed that fishermen should conduct two or three otter hunts per year to avoid being fined (Chanin 1985). Estate game keepers continued over the centuries to persecute these playful animals in the British Isles, pushing them close to extinction.

In Europe, prejudices are gradually fading, but the Common Otter, despite its name, is no longer common. It has declined drastically in Britain and most of western Europe, and is rare throughout much of its range elsewhere in eastern Europe and Asia as a result of continued persecution, fur trapping, habitat loss and chemical contamination of its environment (Chanin 1985). This species is listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the category designating species in danger of extinction, and in which commercial trade is not allowed between the Party nations. The *2000 IUCN Red List of Threatened Species* classifies the species as Vulnerable. An increasing number of people are becoming acquainted with this delightful

animal. Not until 1978 did the otter receive official protection from hunting and trapping in England and Wales, and in the intervening years, a strong "Save the Otter" campaign, begun by Friends of the Earth, has had positive results (Chanin 1985). Surveys completed during the 1970s found that otters had become extremely rare in England, and were in steep decline. In parts of southwestern England, otters are now increasing with legal protection, and they are being reintroduced into areas where they had been hunted or trapped out. In 1982, protection was added in Scotland, in spite of continued opposition from otter hunters and those who harbored old prejudices (Chanin 1985). In the Netherlands, reintroductions of otters are returning them to long vacant habitat.

Izaak Walton's views of the otter were not scientifically refuted until the 20th century. Best known as the author of the 17th century book, *The Compleat Angler*, a compendium of information about fishing in England, he quoted a fishermen of the times: ". . . my purpose is to bestow a day or two in helping to destroy some of those villainous vermon; for I hate them perfectly, because they love fish so well, or rather, because they destroy so much, indeed, so much, that in my judgment, all men that keep otter-dogs ought to have pensions from the King to encourage them to destroy the very breed of these base otters, they do so much mischief." Scientific studies of otter diets established that these animals did not pose threats to game fish populations. A 1942 study found that North American River Otters (*Lutra canadensis*) prefer slow-moving forage fish, such as suckers, mudminnows and sticklebacks, to fast-moving trout. Some game fish are taken, but subsequent studies established that such fish make up a small percentage of the otter's diet. A 1955 study by biologist Richard Ryder examined stomachs of River Otters (*Lutra canadensis*) trapped in Michigan and found forage fishes (primarily mudminnows) in 56 percent, crayfishes in 22 percent, amphibians in 17 percent, insects in 13 percent, and trout in 13 percent of all otters examined. Ryder concluded that otters are opportunistic feeders, catching prey items in proportion to their abundance and in inverse proportion to their swimming ability. Thus they benefit game fish by removing overpopulated fish species that compete with trout for food from streams and waterways. In a dramatic demonstration to illustrate its food preferences, a River Otter was placed in a large tank with both trout and crayfish. Ignoring the fast-moving trout, the otter went directly for the crayfish.

Other species of otters also have been found to prefer slow fish, especially bottom-dwellers not desired by either sport or commercial fishermen. Yet they are still being persecuted in many parts of the world. The Marine Otter (*Lutra felina*), a small otter native to the Pacific coast of western South America, has been so persecuted by fishermen for alleged damage to fisheries (Nowak 1999) that it is now listed as Endangered on the *2000 IUCN Red List of Threatened Species*. The Sea Otter (*Enhydris lutris*), protected from previous hunting for the fur trade, began to recover its numbers in the North Pacific, but has recently declined to Endangered status as well as a result of persecution by fishermen, oil spills and predation by Killer Whales.

One young California Sea Otter filmed by Jacques Cousteau became very tame, cavorting with the cameramen and allowing itself to be petted. A few days after the Cousteau crew left the area, this young otter washed up dead on the beach, having been shot. It was conjectured that this friendly otter had approached a boat with fishermen who shot it. Fishermen have overharvested abalone beds for these extremely valuable mollusks and blamed Sea Otters for depleting them, yet abalone form only a small part of their diet. Some Sea Otters eat no abalone at all, specializing in other foods. Moreover, they eat sea creatures that prey on the kelp, without which abalone and other wildlife would not flourish. This species is considered a positive element in the ecosystem.

River Otters in North America were persecuted by European colonists, many of whom shot them on sight. These animals, described by early explorers as highly visible, bold and playful, became shy, secretive and nocturnal after centuries of persecution and fur trapping in the United States and Canada. By the 1950s, they had disappeared altogether from vast areas in the country, from Pennsylvania south to northern Georgia and throughout the Midwest south of Michigan and Minnesota, west to Utah (Nilsson 1985). Beginning in the 1970s, reintroductions of otters live-trapped in Canada, Michigan and other areas where they are still relatively common, have taken place in West Virginia, Arizona, Tennessee, upstate New York, Missouri and several other Midwestern states. In some cases, the reintroductions have failed, but for the most part, the North American River Otter is on the way to reoccupying its original range.

Otters are not regarded benignly by fish hatchery managers and commercial catfish farmers in the South. State Fish Departments and the Fish and Wildlife Service operate hundreds of hatcheries throughout the country, raising trout and other fish. Many of these are non-native species, such as Brown Trout, a European species, or native species, such as Rainbow Trout, that are released far from their natural ranges for the benefit of sport fishermen. These hatchery programs are regarded negatively by many ecologists who have documented that the released fish often cause great damage to ecosystems, outcompeting native fish and introducing diseases. Yet state and federal agencies conduct control programs on otters who raid their ponds. Rather than screen the ponds from otters, who can hardly be blamed for finding hatchery fish easy to catch, these authorities have had laws changed in many states to allow shooting and trapping of otters that come onto hatchery property. Placing screening over fish ponds and hatcheries--and fencing them--will prevent otters, as well as fish-eating birds such as egrets, herons, Ospreys and Bald Eagles, from preying on the fish being raised. This should be carried out instead of lethal methods, which also sometimes kill protected waterbirds. Such control programs do not achieve success in any case because even if depredating River Otters are killed, other otters will be attracted to the ponds, replacing those killed.

Eleven species of otters are listed by the *2000 IUCN Red List of Threatened Species*, four as Endangered, three as Vulnerable, one as Near-threatened, and three as Data Deficient. This represents a high rate of threat, 85 percent, as the otter, or Lutrinae family, has only 13 species. Otters tend to be thinly distributed in their ranges, wide-ranging, slow-reproducing and long-lived--all qualities that make them vulnerable to population declines.

Seals and Sea Lions

The Caribbean or West Indian Monk Seal (*Monachus tropicalis*) was the first animal seen by Christopher Columbus in the New World in the late 15th century, and his crew slaughtered these seals on an islet off the coast of Hispaniola (Day 1981). The only seals native to the Caribbean, they were quite large--6.5 feet long (Nowak 1999). They were heavily exploited beginning in the 17th century for their oil, which was used as a fuel for lamps and, later, for their fur. Scattered populations of the Caribbean Monk Seal survived on islets and beaches far from human habitation until the 20th century (Nowak 1999). Even these last seals were persecuted by fishermen who regarded them as competitors. The last known population of these seals lived on the Triangle Keys, small sandy islets off the Yucatan Peninsula of Mexico, and in 1911, fishermen slaughtered every one of the remaining 200 Monk Seals (Day 1981). Although a few seals were seen after that time, including the sighting of a small colony on a bank midway between Jamaica and Honduras in 1952, an aerial survey of all possible habitats carried out in 1972, and a 1980 expedition, failed to find any sign that the Caribbean Monk Seal remained alive (Nowak 1999). The species was officially declared extinct a few years later, although a few recent reports have given hope that the species may have reappeared (Nowak 1999).

The Japanese Sea Lion (*Zalophus californianus japonicus*), a subspecies of the California Sea Lion, was native to Japan, North Korea, and South Korea, and shooting by fishermen played a major role in its extinction (IUCN 1978).

Commercial fishermen have been responsible for the near-extinction of the Mediterranean Monk Seal (*Monachus monachus*). Once common along the coasts of the Mediterranean Sea, and along the Atlantic coasts of northwestern Africa, this seal is on the verge of extinction, its status listed in the *2000 IUCN Red List of Threatened Species* as Critical. Although resort and industrial development contributed to its decline, shooting by fishermen has been the major cause (Nowak 1999). Many seals drown when they become entangled in fishing nets as well. In past centuries, these seals could be seen on beaches along the Mediterranean, where they would have their pups. After severe persecution, however, they began to hide in the remote caves along the coasts and on uninhabited islets (Attenborough 1987).

In 1981, Greek fishermen threatened to kill off all the remaining Monk Seals on Greek shores if they were not paid compensation for the fish the seals would eat. The Fauna and Flora Preservation Society (now Fauna and Flora International), a London-based organization, raised the money after public appeals in newspapers, which amounted to several thousand dollars.
Fishermen throughout the region became even more intent on eliminating these seals after commercial factory fishing ships began to deplete fish stocks in the Mediterranean.

In spite of legislation protecting the seals, fishermen continue to shoot these seals, which are suffering from lost food supply in most areas. The once pristine waters are now overloaded with sewage and contaminated by chemical and oil spills (Attenborough 1987). The total population of this seal was fewer than 350 in the late 1980s (Attenborough 1987). A 1996 survey found 288 animals, mainly along the African coast in the Atlantic (*BBC Wildlife* 1996). Unfortunately, the largest population in the African islands was decimated in 1998 by a die-off, apparently caused by toxic chemicals.

Mediterranean Monk Seals are extinct in Cyprus, Lebanon, the Canary Islands and Syria, and probably extinct in most other Mediterranean countries. Researchers are conducting radio tracking studies of young seals to discover breeding calves with the goal of reintroducing the seals in the Canary Islands where they have been extinct for over 400 years (*BBC Wildlife* 1996).

The attitude that seals and other fish-eating animals are depriving humans of food is prevalent in many parts of the world and has resulted in the killing of countless fish-eating mammals and birds. The Marine Mammal Protection Act (MMPA) of 1972, which prohibits killing marine mammals in US waters, allows killing of "depredating" seals and sea lions under permit. Such permits are given to kill seals destroying nets to steal fish and/or having a deleterious effect on commercial fish species through their predation. Some Alaskan fishermen, who net the largest fish catches in the world, still resent that the fish are taken by seals and other marine mammals in their waters, and illegal shooting of these protected mammals frequently occurs. Sea lions along the coasts of California, Oregon and Washington have been shot illegally by the hundreds since the MMPA went into effect, and many permits have been given for legal killing. These killings have had a negative effect on many populations of these sea mammals.

Wild Cats
While it may be difficult for most Americans to think of the regal Cheetah as vermin, in the southern African country of Namibia, cattle ranchers treat these endangered and beautiful cats as enemies, trapping and shooting, and even poisoning them. White South Africans have acquired huge landholdings to raise cattle at the expense of the environment in this arid land, fencing off large sections from native wildlife. The majority of Namibian ranchers lack compassion or respect for this graceful cat and, without any compunction, kill females, young kittens and any adult Cheetah on their properties, whether or not the animals pose a threat to their livestock. One rancher told American conservationist Laurie Marker, who is seeking to reverse this trend, that he personally had killed 160 Cheetahs on his property. Marker has taken on the daunting task of trying to convince ranchers of the importance of protecting these endangered cats.

Cheetahs are the world's fastest land animal, reaching 70 miles per hour in pursuit of gazelles, foals of large ungulates, such as zebra and, occasionally, smaller mammals, such as hares. For hundreds of thousands of years, they have adapted to changes in the environment of their once vast range, and are superbly designed as predators. In the North American Pleistocene, more than 10,000 years ago, a cheetah-like cat ranged over the continent, preying on the Pronghorn, the world's fastest hoofed animal. This cat became extinct, perhaps as a result of hunting by Pleistocene hunters.

Prior to the 20th century, Cheetahs remained common in savannah habitats south of the Sahara, and in 1900, their population may have totaled 100,000 animals. Since then, a steady decline in their populations and a shrinking of their range have placed them in endangered status. Cheetahs underwent a dramatic decline in the 1960s when spotted cat fur became fashionable. US imports were stopped when the species was listed on the US Endangered Species Act in the late 1960s, and commercial international trade became illegal when Cheetahs were included on Appendix I of CITES in the early 1970s. Killing them for the fur trade devastated their populations because they are distributed so sparsely over their range--even a kill of a few thousand in each country endangered them. Added to this, they have endured persecution by livestock herders and ranch owners, combined with loss of savannah habitat and their prey species. In areas where there are large populations of Lion and hyena, adult Cheetahs and their cubs are preyed upon by the latter predators, who also steal their kills (Hunter 1998). Trophy hunting also has taken a toll on these cats.

By the early 1970s, they numbered only 15,000, according to Peter Jackson, head of the Cat Specialist Group of the World Conservation Union (Newman 1997). Cheetah biologist Luke Hunter (1998) estimates their total population today at a maximum of 12,000 animals, with safe populations in only five or six of the 26 countries where they may be present. In parts of southern Africa, Cheetahs were numerous until a few decades ago when white ranchers fenced off thousands of square miles of grassland. Within these ranches, which cover much of the land area in Namibia and Botswana, landowners killed off predators as well as native ungulates. The once abundant wildebeests, zebras, oryx, gazelles and antelope that migrated in the hundreds of thousands in this region became reduced to scattered numbers.

Namibia, with its arid, open habitat, still has about 2,500 Cheetahs, perhaps the largest population in Africa, but at the present rate of killing by ranchers, they will be extinct there within a decade. In the 1980s, 1,000 Cheetahs were killed by ranchers, and the Namibian Cheetah population dropped about 50 percent between 1984 and 1994 (Schick 1994).

A 1997 PBS television special, fiIn the Wild,fl featured actress Holly Hunter traveling to southern Africa in search of Cheetahs. A visit to Namibia's Etosha National Park, where these cats were once fairly common, failed to find a single Cheetah, in spite of expert help from native Bushmen trackers. An outbreak of Anthrax, spread by domestic livestock, had recently occurred in the park. Some 20 Cheetahs had died, and the disease also killed elephants and other wildlife.

Marker co-founded the Cheetah Conservation Fund in 1990, and since it has been in operation, it has changed many ranchers from Cheetah-haters to Cheetah-protectors. Few knew of the Cheetah's worldwide plight, and many cooperated when informed. One successful strategy to protect livestock introduced by Marker has been the use of donkeys to guard cattle herds. These animals easily fend off Cheetahs with their powerful kicking hooves (Schick 1994). Baboons have also been trained to guard livestock because of their aggression toward Cheetahs (Schick 1994). Recommendations such as bringing cows closer to homesteads during calving season have also been made to ranchers (Schick 1994). Many ranchers did not realize that Cheetahs prey on livestock only when their own natural prey, primarily gazelles and Impalas, have become scarce because of killing or fencing by the ranchers (Schick 1994).

Within the past few years, many ranchers have been convinced to use box traps to capture Cheetahs unharmed instead of killing these cats. Marker ear-tags the animals and returns them to local protected areas (Schick 1994), or arranges to have them moved. In the early 1990s alone, 75 Cheetahs were removed from ranches where they were being persecuted and were introduced into other areas. One farmer caught a female with five cubs and wanted to keep the cubs as pets. Marker convinced him to give up the female and four of her cubs, but he insisted on keeping the largest one. Although keeping Cheetahs as pets is not good for their welfare or conservation, it is an improvement over their wholesale destruction. Leghold traps are used by some ranchers, and in 1996 Marker acquired two 3-week-old Cheetah cubs whose mother had been killed in one of these traps. They will have to remain in captivity because of their young age when orphaned.

An organization known as Africat has sponsored the capture and transport of 100 wild Namibian Cheetahs to South Africa. This organization reports that ranchers capturing Cheetahs in large box traps often sell them to breeders rather than reintroduction programs, a practice that it does not condone. Translocating adult Namibian Cheetahs to South African reserves where they had become extinct has been very successful. In one case in 1995, three males were

released in Madikwe Game Reserve where four other Namibian Cheetahs had been introduced in 1994, and all survived. A male, four females and five cubs were released in Pilanesburg National Park in 1995, and there were no fatalities (*Oryx* 1996). Most of South Africa's Cheetahs were eliminated by Boers in the 19th century, and the government is now returning them to their original range within national parks. Outside of national parks, they may be in as great danger as the Cheetahs further north.

Lions have continued to decrease in Africa south of the Sahara from a variety of factors, of which persecution by livestock raisers is a major one. Outside of national parks, these big cats have become rare or absent, and in 1996, the species was first listed by the IUCN as Vulnerable. The *2000 IUCN Red List of Threatened Species* also classified the African Lion as Vulnerable. They disappeared long ago from areas with scarce ungulate populations and large numbers of herdspeople who persecuted them, such as the arid regions of southern Africa and the sub-Saharan. In recent years, they have declined throughout the continent. Outside of parks, the Maasai and other tribes with livestock herds routinely kill Lions and other predators to protect their cattle (Hunter 1998). Lions are particularly vulnerable to persecution and hunting because, like wolves, they hunt in groups. When persecuted, they may not be able to survive hunting alone or in pairs.

Some parks are not large enough to maintain healthy Lion populations, and when they leave parks to wander in search of prey, they are often killed by ranchers or hunters. In the southern African country of Namibia, for example, the 300-mile-long, 25-mile-wide Skeleton Coast National Park skirts the Atlantic coast. Two filmmakers, Jen and Des Bartlett, chronicled the disappearance of Lions from the park. A small population of Lions inhabited the park in the early 1990s, and one pair was radio-collared by park rangers. Shortly thereafter, both Lions were shot dead by livestock herders when the Lions left the park. The Bartletts had known the female for five years, and she was pregnant with four cubs when shot. The killing of Lions to protect livestock is legal in Namibia, and with the death of the last specimen in the park, an elderly and emaciated animal shown in their National Geographic Society film, fiSurvivors of the Skeleton Coast,fl these great cats are now extinct in the area.

Wild cats have been hunted heavily and killed off throughout the Middle East. Leopards (*Panthera pardus*) still persist in small pockets, escaping detection with nocturnal hunting, and hiding in rock crevasses and trees during the day. As a general rule, wherever Leopards are seen in the Middle East, they are shot or poisoned as potential threats to the ubiquitous sheep and goats. In a few areas, such as remote portions of the Saudi Arabian Peninsula, Leopards are protected in national parks. These Leopards are very adaptable in their prey and can subsist on small animals, such as hares--unlike the Lion, which requires larger prey.

Eight subspecies of Leopards are listed on the *2000 IUCN Red List of Threatened Species*, all in Endangered or Critical categories. They range from North Africa across Asia to Java, Indonesia. Races such as the South Arabian Leopard (*Panthera pardus nimr*) of Saudi Arabia, United Arab Emirates and Yemen; North Persian (*P.p.saxicolor*) of Afghanistan, Iran and Turkmenistan; and the Anatolian Leopard (*P.p.tulliana*) of Turkey, have populations so small that they may become inbred and disappear within a few decades. The South Arabian Leopard is the focus of a conservation program organized by officials and conservationists from Saudi Arabia, Yemen, Oman and the United Arab Emirates. Only 100 to 200 of these cats survive, and they continue to be persecuted by livestock owners and hunters (*Oryx* 1996). The "Leopard Group of Arabia" was formed in 1995, and each country will prepare a plan for conservation of the Leopard, review its own wildlife legislation, conduct surveys, and make proposals for protected areas (*Oryx* 1996). This group is also working to increase populations of native prey, reduce livestock numbers in the Leopards™ habitat, and conduct public education programs (*Oryx* 1996).

Snow Leopards (*Panthera uncia*), native to the mountains of Asia, from Pakistan east to China, are endangered from hunting for pelts and as trophies, and by persecution from herdsmen who kill them as a threat to their livestock. Their total population may be as low as 4,500 or as high as 7,500 (Sunquist 1997). In their stark, rocky and high desert habitats, these cats prey upon wild sheep, goats, deer and marmots (Sunquist 1997). Their original range stretched for 4,000 miles and encompassed 1.2 million square miles in a wide arc, curving from east to west in the Himalayas through former Soviet Republics, Nepal, Pakistan, Afghanistan, Bhutan, Sikkim, and Mongolia to China, including a

total of twelve countries (Baillie and Groombridge 1996). They have disappeared from vast areas within this region, however, and continue to decline.

Until the 20th century, few herdspeople roamed these remote and forbidding regions, and Snow Leopards and their prey were left unmolested in most areas. In the past 50 years, however, human populations have risen dramatically. In western China, the government has used subsidies to encourage settlement of the western steppe, and large numbers of people have entered previously uninhabited areas with their livestock. In western Nepal, villages now dot the Himalayan slopes at 9,800 feet, and people scratch out a living from meager potato, barley and wheat crops (Sunquist 1997). Each household has only a few sheep and goats and cannot afford to lose even one to predators (Sunquist 1997).

Some 1 million Mongolian herders subsist in a barren landscape, dependent on their yaks, goats and sheep. These people, whose livestock compete with wildlife for the scarce grasses, also hunt native animals which the Snow Leopard needs to survive--Blue Sheep, ibex, deer and others. Even marmots are killed in very large numbers for their meat and skins (Sunquist 1997). When their natural prey disappears, and Snow Leopards begin to prey on livestock, herders poison, trap or shoot these cats in retaliation. In many areas, herders kill Snow Leopards as a potential threat, even when they have not lost livestock, in order to sell their valuable pelts.

Dr. George Schaller of the Wildlife Conservation Society has conducted studies on the diet of Snow Leopards and, in most areas, found less than 5 percent of livestock in their diet, based on feces analyses (Schaller 1998). As numbers of livestock in the Snow Leopard's range rise and herders penetrate further into the mountains and high pastures, livestock losses occur that sometimes result in extermination campaigns (Schaller 1998). Herding practices in these areas often encourage predation by Snow Leopards, with sheep and goats, and mares with their foals left unguarded (Schaller 1998). Depletion of their prey has increased in recent years, with government policies that encourage marmot hunting, pika poisoning and, until the late 1980s, Blue Sheep market hunting (Schaller 1998).

In Tibet, Dr. Schaller has arranged with local herdspeople to pay them for any losses they incur to Snow Leopard predation, and he has hired local Tibetans to assist in field studies of these cats, giving them a financial incentive to protect the cats. Likewise, in Pakistan, a new program organized by an American conservationist, Helen Freeman, founder of the Seattle-based International Snow Leopard Trust, has sponsored some 90 projects for the species, including many field studies. Its web page (www.snowleopard.org/islt) follows the movements of radio-tracked Snow Leopards. Gary Larson, the popular *Far Side* cartoonist, created a Snow Leopard design for the organization to use on its shirts (Sunquist 1997). Grade-schoolers all over the country have raised money by selling T-shirts for the International Snow Leopard Trust. In 1988, through the education programs and compensation for livestock losses conducted by this organization, a Pakistani livestock owner trapped a young Snow Leopard found preying on livestock, contacted the government and, before news crews, set it free. In the past, it would have been killed routinely.

The International Snow Leopard Trust and the Mongolian Association for Conservation of Nature and Environment are providing tea, noodles and clothing to livestock grazers in Snow Leopard territory in the Altay Mountains of Mongolia, with the understanding that they will protect wildlife (Schaller 1998). One village requested children's clothing, flour, candles, soap and tea, and these requests were filled (Sunquist 1997). The concept of involving local people in the conservation of wildlife is extremely important and, wherever practiced, has had beneficial long-term results for all concerned.

Bats

Bats live on every continent except Antarctica and serve extremely important ecological roles as pollinators, seed

dispersers and consumers of vast quantities of insects. Although some societies value these useful animals, many persecute all bats, based on irrational prejudice and fears of rabies. The Romanian legend of Dracula, in which a man turns into a blood-thirsty vampire bat at night and flies about seeking victims, has created a ridiculous and false impression. Real vampire bats are small, only about 3 inches in length and weighing about an ounce (Wilson 1997). The three species inhabit neotropical forests and are rare in natural habitat. Only when large numbers of livestock are grazed in an area do these mammals, who suck blood from large animals such as livestock, become common (Wilson 1997). They rarely cause the livestock harm. They are capable of transmitting disease to their host animal, but very rarely do so (Wilson 1997). Bat Conservation International has worked effectively to allay fears about vampire bats and helped many people to see them in the positive light of their value to ecosystems, economies (through pollination), seed dispersal and insect control and their interest as diverse, successful species. But Dr. Merlin Tuttle, founder and Executive Director of the organization, believes that persuading the public that bats are not to be feared is still an uphill battle, in spite of progress made in education programs (Raver 2001). Exaggerated headlines about bats and rabies tend to undo rational education programs. In fact, Dr. Tuttle says that over the past 20 years, the United States has had 1.5 human cases of bat rabies per year, hardly deserving the hysteria that so many people feel at the mere mention of bats (Raver 2001).

One positive change in recent years is the increase in people who rise to the defense of bats when newspaper stories appear about the threats of vampire bats and bat control in buildings (Garvin 1999, Gross 2000). Letters to the editor often make the point that bats are basically beneficial, and articles depicting them as fearsome enemies are misleading and cause persecution of wild bats. One article in *The New York Times* (Gross 2000) profiled a bat control professional who paid house calls when people complained of bats having entered their homes. He set glue traps, which bats blundered into and then broke their necks, and sent their bodies to a laboratory in the state capital for rabies testing (Gross 2000). Experts have found that only 1 to 4 percent of bats are rabid, and conservationists suggest that bats be set free rather than killed (Gross 2000). A more humane approach to the problem of bats in the attic was developed by Cal Kosky, a wildlife biologist with the Pennsylvania Game Commission. He tapes a piece of plastic or netting over the top of the entrance hole on the outside of the house (Raver 2001). Bats are able to fly out, but are blocked on return. A bat house is placed strategically close to the old hole to provide them with a new home (Raver 2001). Bat Conservation International has an educational video, "Building Homes for Bats," which explains how to construct bat houses to attract bats to backyards where they eat mosquitoes and other insect pests (Raver 2001).* Sensible advice can also be obtained from Dr. Tuttle's 1988 book, *America's Neighborhood Bats. Understanding and Learning to Live in Harmony with Them*.

Prejudice against bats has had serious consequences for many populations that roost in accessible places, such as open caves. The largest bat colony in the United States, located in Eagle Creek Cave in Arizona, had 30 to 50 million individuals until the 1960s, when vandals and human disturbance reduced them to only 30,000 (Wilson 1997). Several species of North American bats have become endangered as a result of deliberate killing by people, disturbance by spelunkers, and tourists entering the caves (Nowak 1999). The Gray Bat (*Myotis grisescens*) and the Indiana Bat (*Myotis sodalis*) of the eastern and Midwestern United States, for example, are both endangered as a result of these activities. Dr. Tuttle has found that the total number of Gray Bats in 22 major summer colonies declined from 1.2 million prior to 1968 to 293,600 in 1976, a loss of 75 percent (Nowak 1999). The Indiana Bat fell from 640,361 in 1960 to 459,876 in 1975; by 1993, 347,890 remained (Nowak 1999). Both species are listed as Endangered by both the *2000 IUCN Red List of Threatened Species* and the US Endangered Species Act. In Europe, the Pond Bat (*Myotis dasycneme*), a related species, has been reduced to only 3,000 in western Europe and fewer than 7,000 in its entire range (Nowak 1999). It is listed as Vulnerable by the IUCN. Many other European myotis bats also have declined to Endangered or Threatened status from habitat loss, disturbance of hibernating colonies in caves and mines, and blocking up of nursery sites in large buildings, such as cathedrals and castles (Nowak 1999). Rather than killing bats that roost in buildings, or blocking up entries, Bat Conservation International encourages the placement of bat houses nearby, which the bats tend to occupy instead. Similar efforts are needed in Europe. Even when allowed to roost in buildings, many bats are poisoned by chemicals used to treat wood in western Europe (Nowak 1999).

Bat caves are often vandalized when bats hibernate in the winter. Vandals enter caves and knock semi-conscious bats

to the ground, killing them by the thousands, or even millions. Even entering a hibernation cave can result in mortality because disturbances can arouse them and they use up so much stored energy that they do not survive the winter (Wilson 1997). Many bat caves now have gates that allow bats to fly through the open grating, but keep people out; they have helped protect important bat hibernation areas where bats from large areas congregate (Wilson 1997).

The importance of bats as pollinators is discussed at length in *The Natural History of Pollination*, by Michael Proctor, Peter Yeo and Andrew Lack (1996). Many types of flowers have evolved to be pollinated by bats, opening only at night. Their internal pollen-carrying structures are designed to drop pollen on the bat's face when it feeds on nectar (Proctor *et al*. 1996). A great variety of bats and plants coexist, perfectly adapted to one another. Dr. Tuttle's dramatic photos of many such flowers have been published in *National Geographic* magazine and in the useful book, *Bats in Question. The Smithsonian Answer Book* (Wilson 1997). He also has made films of bats for nature documentaries. Many bats are extremely attractive, and their sonar is so complex and sensitive that it is only partially understood by scientists. *Walker's Mammals of the World*, by Ronald Nowak (1999), is another important source of information on bat biology, taxonomy, behavior, conservation and related subjects.

After rodents, bats have the greatest number of species of any mammals, with the most diversity in tropical areas. The number of threatened species has increased dramatically over the past decade as a result of persecution, killing for food, pesticides and other toxic chemicals, and loss of their habitat (see Appendix for list of threatened species). The majority of species at risk suffers from a combination of these factors.

*This video can be ordered online at www.batcon.org or by calling 1-800-538-BATS.

Birds of Prey

Birds of prey have been persecuted for hundreds of years in Europe and other parts of the world, usually as suspected predators of chickens or small livestock, such as goat kids or lambs. In most parts of the world, they still are given no official protection.

Hawks, eagles, owls, falcons and other birds of prey that breed in North America were excluded from the 1918 Migratory Bird Treaty Act (MBTA), signed with Great Britain on behalf of Canada. The Treaty covered almost all other species of native birds, banning hunting and killing as well as harassment and destruction of nests. This exposed birds of prey to continued indiscriminate shooting for sport, hunting from aircraft, poisoning and even capture in pole traps, which catch birds by the feet and hang them upside down in nooses.

Populations of birds of prey that breed in Canada and the northern United States migrate south during the fall, some to Latin America and others to southern states. Flying along thermal wind currents, they funnel into flyways as they pass through mountain chains. In the eastern United States, thousands of hawks, and a smaller number of eagles and falcons, pass over the Allegheny Mountains of Pennsylvania during October, November and December every year. Kittatinny Ridge, near the town of Kempton, came to be known as Hawk Mountain because of the huge numbers of birds of prey passing near it. For generations in the 19th and early 20th centuries, hunters gathered every fall on the rocky ridge to shoot these birds by the hundreds as they soared by. Dead hawks, falcons and eagles accumulated in huge piles, while wounded birds staggered around or lay helplessly immobile on the ground (Brett 1973).

This carnage was considered a form of sport, justified by old prejudices. Rosalie Edge, an ardent conservationist, spearheaded the movement to stop this hunt in the 1930s (Brett 1973). This courageous woman publicized the slaughter of birds of prey, and after a campaign in which she enlisted the help of influential conservationists, she succeeded in purchasing the mountain as a sanctuary (Brett 1973). Edge persuaded an ornithologist, Maurice Broun,

and his wife, to oversee the sanctuary and prevent hunting. They remained on Hawk Mountain for 32 years and served as guides for the more than 40,000 visitors who come every year to see the spectacle of hawks flying over and alongside the mountain ridge (Brett 1973). Rosalie Edge died in 1962, but the sanctuary continues as a non-profit organization staffed with ornithologists, educators, and volunteers, who chronicle by species and number the birds that fly past the ridge.

Hawk Mountain Sanctuary is one of the country's first examples of private ecotourism, and it has accomplished a great deal in teaching the public about birds of prey as useful animals in ecosystems, as well as providing exciting views of these birds as they soar past the ridge. In the morning, before the thermal winds warm up, hawks fly at low elevations, giving visitors a view of their tails and backs from above, an especially colorful sight in the case of the Red-tailed Hawk (*Buteo jamaicensis*), while in the afternoon, they fly higher, transported along by the thermals. Sometimes a visitor to Hawk Mountain can see a hawk or other bird of prey at close range, only 15 or 20 feet away, as they fly close to the ridge, the intricate patterns of their feathers in full view.

In spite of the preservation of Hawk Mountain and several other key hawk habitats, legal protection from hunting did not come in the United States until 10 years after the death of Rosalie Edge. During these years, thousands of hawks and other birds of prey were shot because of ignorance or as sport. Little was understood about their value in controlling rodents and rabbits. In 1960 alone, 12,000 Golden Eagles (*Aquila chrysaetos*) were killed in Texas in a massive campaign to eliminate them. A major victory for birds of prey was their addition to the Migratory Bird Treaty Act in 1972. The bans on hunting that have protected other native land birds were finally accorded these raptors. This was carried out through a memorandum enacted with Mexico, which had signed the Migratory Bird Treaty Act in 1936. It prohibits, except as allowed under specific conditions, the taking, possession, purchase, sale, or bartering of any migratory bird, including the feathers or other parts, nests, eggs or migratory bird products. "Taking" is defined as pursuing, hunting, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, or collecting migratory birds. Individuals and organizations may be fined up to $5,000 and $10,000 respectively, and those convicted may face up to six months imprisonment for misdemeanor violations of the Act. Felony violations may result in fines of up to $25,000 for individuals and $500,000 for organizations and up to two years imprisonment for those convicted. This strong legislation has not stopped the killing of birds of prey altogether, but it has deterred the type of slaughters that were once common.

Although Bald Eagles were revered by native tribes, especially those in the Pacific Northwest, they became victims of prejudice by European colonists, who accused them of damaging fish stocks. A bounty in Alaska resulted in the killing of some 150,000 of these eagles between 1917 and 1953. This species is the national bird, the official symbol of the United States of America, yet historically it has been given little respect. Some even called them "gangster birds" because they were thought to be scavengers of fish caught by other birds. In truth, they are superb fishers with extraordinarily keen vision and are acrobatic in flight. Bounty programs and random shooting of Bald Eagles from colonial times onward caused these birds to disappear from much of their original range, which encompassed the entire continent of North America, including arid regions in the Southwest.

The Bald Eagle Protection Act was enacted in 1940 to protect it from extinction, and amended in 1962 to extend protection to Golden Eagles, primarily to protect immature Bald Eagles, which resemble them. A 1972 incident involving the slaughter of hundreds of Golden Eagles by western ranchers shooting from aircraft resulted in increasing fines under the law from $500 to $5,000 and/or one year imprisonment for subsequent offenses. The amendments also specifically included poisoning in the definition of taking, since both Bald and Golden Eagles had been poisoned by ranchers. These amendments also included the same high penalties for possession of eagle feathers, nests or eggs, and made federal grazing permits subject to cancellation for violations of the Act. In addition, they added a new facet to the enforcement of the Act: one-half of any fine can be paid to a person who provides information leading to a conviction. To augment this protection, the Airborne Hunting Act was enacted in 1972 to prevent the killing of wildlife from aircraft.

After 1973, the killing of a Bald Eagle constituted a violation of the US Endangered Species Act, the Bald and Golden

Eagle Protection Act, and the Migratory Bird Treaty Act, the combined penalties of which could amount to long jail sentences and very high fines. In spite of all these legal steps taken to protect eagles, killings continue. Many are deliberate and carried out in remote areas where there is little fear of prosecution, and others are done by hunters ignorant of the law or the identity of their targets. The protection of native birds, their identification, and laws applying to them should be taught in schools in North America, but such information is usually acquired by chance if at all. Each year, 300 to 400 eagles--Bald and Golden--are found dead. In some cases, hunters still believe folklore about birds of prey being destructive, and shoot them intentionally. A Bald Eagle shot in Maine in 1994 was killed by an 85-year-old man who deliberately killed the bird because he believed these birds were killing geese. He told game wardens that they should "do something about the eagles;" because of his age, he was only given a $2,500 fine, which was suspended. Bald Eagles feed mainly on fish and are not major predators of waterfowl.

Although the majority of eagles are killed when shot, many are found wounded, some in emaciated condition, unable to fly to obtain food and near death. One such Bald Eagle was found crippled in 1983 in Georgia, having been shot in the wing. He had been on the ground for a week, his wing bone exposed. In spite of attempts to save his wing, veterinarians had to amputate it because of infection, and the eagle was taken into a rehabilitation program. Named Osceola, he has played an important role in Wings of America, an education program at Dollywood in Tennessee. John Stokes, Osceola's caretaker, teaches children and adults about the effects of such shooting, stressing the impoverished life that Osceola leads, unable to fly and be free. Stokes decided to bring Osceola along on his hang-gliding trips to treat the bird to some of the sights the eagle had not seen in the many years since being shot. Harnessed into a specially made sling, the pair hang-glided, with Osceola positioned above Stokes, looking intently at the ground far below, turning his head frequently in apparent fascination. The film of Osceola hang-gliding was shown on nationwide television in 1996, and some 500,000 people attend lectures featuring this maimed eagle every year. The National Audubon Society series for young people, "Audubon's Animal Adventures," featured Osceola in the program entitled "Eagle Adventures," shown on the Disney channel.

In the past, it was impossible to prosecute offenders unless there were witnesses or other direct evidence to the killing. Today, a state-of-the-art forensic laboratory run by the US Fish and Wildlife Service in Washington state is able to necropsy dead eagles for cause of death. If shot, ammunition extracted from the birds is analyzed forensically, and cases are made with as much precision and scientific evidence as criminal investigations in which people are the victims.

Prejudices against birds of prey still persist among many who wrongly believe that they harm wildlife or present major threats to domestic animals. Biological studies have documented their ecological importance as major controls on rodent populations. Some birds of prey feed on snakes, insects or other potential pests. No species of raptor poses a significant threat to domestic animals.

The continent's densest population of birds of prey breeds in the craggy canyons and sagebrush shrubland of Idaho. This area has been set aside as the Birds of Prey National Conservation Area, lining 81 miles of the Snake River and covering 485,000 acres. Prior to its protection, this land was in the process of being converted to agriculture. The birds of prey had begun a steep decline from shooting and loss of habitat. Conservationists faced strong opposition to the plan, but overcame it, establishing this area in 1971, a year prior to the inclusion of birds of prey on the Migratory Bird Treat Act. It has since become a leading ecotourism destination for rafters and hikers, who are led on tours by naturalists from the Bureau of Land Management (BLM), which oversees the refuge. Fourteen species of raptors breed in the area or migrate through it, and the breeding population of hawks, eagles, owls and falcons has been estimated at 800 pairs. They provide exciting views of high-speed hunting of ground squirrels and birds, and their eerie shrieks resound through the canyons.

Waterfowl hunting is regulated by the Migratory Bird Treaty Act under regulations by the Fish and Wildlife Service. Unfortunately, the regulations have serious shortcomings that have resulted in many shootings of birds of prey. First, hunting can begin before dawn, when hunters are unable to identify birds by species. Each year, hundreds of birds of prey, including such endangered species as Peregrine Falcons, are shot accidentally. Second, the regulations do not

require that hunters be able to identify birds by species, including protected and endangered species. Since many ducks and geese are extremely difficult to identify, the failure of the Fish and Wildlife Service to require hunters to pass identification tests and begin hunting well after daybreak means that protected and endangered birds will continue to be shot.

In October, 1995, a Peregrine Falcon (*Falco peregrinus*) shot in Massachusetts was migrating south from Canada or Greenland during hunting season. It suffered neurological damage after being shot in the left wing while it was flying in a wildlife refuge area. The Assistant Director of the State Division of Fisheries and Wildlife, Tom French, stated that it appeared that the bird was not shot accidentally. This was the second shooting of a Peregrine Falcon in as many years. The reintroduction of captive-bred specimens of these birds into the eastern United States has been a success, with over 130 nesting pairs. Their long-term survival, however, will depend on adherence to laws prohibiting shooting or harming them.

For the future, the Migratory Bird Treaty Act would be far more effective if signed with Latin American and Caribbean nations to protect North American birds wintering in those countries. This would be especially important in view of the decline in many of the continent's birds of prey, which are persecuted and killed by pesticides and poisons in their wintering grounds.

The California Condor (*Gymnogyps californianus*), North America's largest bird of prey, once soared over most of the continent. Its bones have been found among Florida's Pleistocene fossils, and 20,000 years ago, it was very common and widespread, feeding on the carrion of mastodons, bison and other large mammals. This giant bird's superb aerodynamic flight makes the most sophisticated man-made aircraft look clumsy by comparison. Condors have a positive role to play in ecosystems, feeding on carcasses and thereby ridding the environment of these potentially infectious contaminants. Although they declined in range over the centuries, condors were still widespread from Baja California, Mexico, north to Washington state, where Lewis and Clark saw them along the Columbia River in the early 19th century. They were often observed scavenging seal and whale carcasses along the California coast, and they nested as far east as the Sierra Nevada Mountains.

Settlers looked on condors as large targets, with their 10-foot wing span, and perhaps thought they were predatory birds. Hundreds were shot. These birds feed exclusively on carrion and do not hunt live animals. When word spread in the last years of the 19th century that the condors were approaching extinction, egg and specimen collectors preyed on the remaining birds. Between 1881 and 1910, 288 birds were killed as museum specimens (ICBP 1981). By the turn of the century, only a few hundred birds remained, yet killing was still legal. The ornithological journal *The Condor* began publication at this time and recorded many instances of these killings. In one case, an individual named Frank S. Daggett reported shooting a California Condor in 1901, wounding it in the wing and then, when it fell to the ground, shooting it three more times, still not killing it. Finally he clubbed it and shot it yet again before the bird died (Daggett 1901).

The California Condor continued its decline until only 60 birds remained in 1939 (Greenway 1967). The last population survived in a wilderness area of southern California. In spite of legal protection and the establishment of the Sespe Condor Refuge, the birds suffered high mortality from shooting, ingestion of lead shot from deer killed by hunters, feeding on animals killed by predator poisons, collisions with power lines, and accidental capture in leghold traps. Biologists from the Fish and Wildlife Service and the National Audubon Society were assigned to study and protect this small population in the 1960s and 1970s, but they did not publicize its precipitous decline or insist on further protection from the threats that continued to kill these birds. As these birds headed toward imminent extinction, nothing was done to stop deer hunting in their refuge, nor to prevent the use of steel jaw leghold traps or predator poisons in their diminishing range.

One of the last nests was in a regal setting befitting this massive bird: a huge natural hole in a giant, old Sequoia tree. The eggs from this nest and others were taken by the Fish and Wildlife Service for captive hatching. In 1980, one of the last wild chicks hatched in a cave and was being weighed and tested by biologists when it suddenly died. It had

been handled for more than an hour, during which time it repeatedly hissed and jabbed at the researcher. Later it was revealed that shock caused its death. The incident was filmed and shown on national television, resulting in the cancellation of the recovery program by the state of California, followed by a long period of re-evaluation and controversy. By 1981, the state reached an agreement with the Fish and Wildlife Service to allow capture of the last nine California Condors, but the program was delayed by lawsuits and wrangling over details. By the time it was finally decided to capture all remaining condors in 1987, only six survived (BI 2000).

The sad decision to remove all wild California Condors turned out to be the correct path to preserve the species, since its wide-ranging behavior exposed it to countless perils that were beyond the control of its protectors. To the amazement of many, the captive-breeding program succeeded beyond all expectations. The eggs laid by the captive condors were artificially incubated, and chicks were fed by workers, with puppets resembling adult condors covering their hands. So many birds were captive-bred at special facilities run by the Los Angeles Zoo and other breeding centers that by 1992, a reintroduction program began with release of captive-bred birds into the wild in southern California. Some of the released birds died after striking electric power wires or were injured and had to be returned to captivity. Several landed in suburban locations, perching on the decks and roofs of private homes and even, in one case, entering someone's home. Most residents did not recognize the birds™ great rarity and protected status, and put out food, such as hot dogs, for them. Finally, wildlife authorities and television news stations learned about the situation, and many Californians became aware of these giant and extremely rare birds. To many ornithologists, the behavior of these young condors indicated that the birds were tame and considered humans a source of food. The puppets apparently had not fooled them into thinking they were being fed by parent birds.

By July 1994, California Condors numbered 89 birds, 85 of which were in captive-breeding facilities, and four released birds (Collar *et al*. 1994). Six young condors were released in the Grand Canyon area in late 1996, with Fish and Wildlife Service personnel staying close to provide food and to radio-track the birds. Within a short time, one of the condors was killed by an eagle, an unexpected setback. The total California Condor population grew to 120 birds by early 1997, and only a year later it had increased to 147 birds, of which there were 97 in captivity, 28 returned to the wild in California's Los Padres National Forest, and 22 released in Arizona (BI 2000). The released birds are provided with livestock carcasses until they are able to find food on their own. The success of this program has not yet been proven by breeding in the wild, as all released birds are too young. Only time will tell whether these birds survive and reach the goal of 150 birds in separate populations. They are being trained to avoid some of the sources of mortality that killed them in the past, such as power lines, but as long as lead shot is used in deer hunting in their range, this will remain a potential threat to them.

Elsewhere in the world, birds of prey receive little or no protection from persecution. In Italy, shooting of migrating birds of prey has long been a "sport" in which gunners position themselves in concrete bunkers on hillsides and kill hawks, falcons and eagles as they fly by. One woman decided to fight the hunters and worked successfully for an official ban on shooting these birds. In spite of this, illegal shooting takes place in Italy, and every year during the migration season, conservationists from many parts of Europe come to help her enforce the ban. The campaign to stop hunting of these birds was described in a film, fiAnna and the Honey-Buzzardsfl (see Video section). In Australia, persecution of eagles and hawks is rampant. After shooting these birds, especially Wedge-tailed Eagles, they are often nailed to fence posts with their wings spread. Few of the ranchers who kill thousands of these birds seem aware of the important role they play in controlling rabbits.

Snakes

The prejudice against snakes may be traced in some cultures to the Biblical story of Adam and Eve, in which the snake represents the evil temptor. For many, snakes inspire great fear and loathing, and they are often killed upon sight. In the American West, rattlesnake hunts are carried out in many towns as an annual event, with thousands of

snakes captured. After being prodded and manhandled, they are killed, often by being skinned alive. The New Mexican Ridge-nosed Rattlesnake (*Crotalus willardi obscurus*) is a threatened species on the US Endangered Species Act, persecuted and overcollected in its limited range. In Eastern states, especially in the South, snakes are also hunted for sport, burned alive with gasoline poured down their dens, and killed in bizarre religious ceremonies. One town in Georgia has an annual war on rattlesnakes, killing as many as possible. For some species, this has resulted in serious declines. The Eastern Timber Rattlesnake (*Crotalus horridus*), the largest snake native to the United States, inhabits forested areas with rock faces, crevices and caves in the Northeast. It has become threatened in many parts of its range. These snakes, which range in size from 35 to 74 inches in length, are vulnerable to persecution because they congregate in large numbers in rocky dens and overwinter with other types of snakes for warmth. They hide under rocks where hunters and collectors find them. Timber Rattlesnakes are long-lived, known to survive 30 years or more. Females give birth only every other year, do not mature until age 4 or 5, and have only 5 to 17 young (Behler and King 1979). With such slow reproduction, they are vulnerable to declines when hunted.

This species has legal protection from hunting in Pennsylvania and New York and is listed on their state endangered laws, yet hunting still kills hundreds each year. One rattlesnake hunter, profiled by CNN, bragged that he had captured 9,000 Timber Rattlesnakes in his lifetime and planned to continue openly flouting laws protecting the species. He claimed that he enjoyed catching and killing these snakes so much that he would never stop, and some herpetologists accuse this man of single-handedly causing declines. He has been arrested many times and jailed for trading in endangered species, but refuses to stop. These snakes do not pose a threat to people unless they are sought out in their retreats.

Biologists point out that snakes are extremely useful ecologically, feeding on squirrels, mice, rats and other rodents, but since laws in the United States and around the world either fail to protect snakes or are not enforced, snakes often are persecuted and killed senselessly.

Rodent Control

Prior to settlement of North America, prairie dogs of many species inhabited towns of burrows that covered some 98 million acres of shortgrass prairies, from southern Canada to Mexico. One prairie dog town in the Texas Panhandle stretched over 25,000 square miles and held an estimated 400 million animals (Dold 1998). Prior to the 19th century, they are thought to have numbered 5 billion animals (DeBlieu 1993). These towns have since been destroyed, the prairie dogs killed, and the habitat used for agriculture, pastureland and development. A keystone species, prairie dogs create habitat for hundreds of other animals who live in their complex burrow systems. These rodents have been driven to endangered status after centuries of persecution and poison campaigns that were based on the belief by cattle ranchers that prairie dogs ate too much grass, depriving cattle of fodder. The US government sponsored the destruction of prairie dog towns beginning in 1900. The poisoning program was bolstered by inaccurate information from the US Biological Survey, which stated in 1902 that prairie dogs decreased productivity of grasslands by 50 to 75 percent (Dold 1998). Poison bait was distributed in the towns, gasoline was poured into their burrows and set afire, and they were shot by the thousands. A highly toxic poison, 1080, was used from the 1960s on, devastating prairie dog towns and killing vast numbers of animals, from foxes to Golden Eagles, who fed on the poisoned prairie dogs. This reduced prairie dog habitat to about 1.5 million acres, a fraction of their original range.

Modern biological research has unveiled the truth about the effect of these rodents on grasslands. Rich Reading, Director of Conservation Biology at the Denver Zoological Foundation, stated flatly that the Biological Survey's figures claiming that prairie dogs reduced grass by up to 75 percent, were "vastly in error" (Dold 1998). Studies by Dan Uresk, a Forest Service biologist, have concluded that prairie dogs eat only a small percentage of grass--from 4 to 7 percent (Dold 1998). James Detling of Colorado State University in Fort Collins has found that prairie dogs are natural fertilizers, whose incessant grass clipping increases the protein content and digestibility of grass (Long 1998).

Other studies have examined the claims of cattle ranchers against prairie dogs and have demonstrated again and again that these rodents actually improve forage quality for livestock and, by cropping the shortgrass prairie, stimulate it to grow, increasing the amount of grasses around the towns (Wuerthner 1996). The American Bison prospered in herds of 50 million, much of the species range lying within prairie dog towns of the short-grass prairies. Their major predator, the highly endangered Black-footed Ferret (*Mustela nigripes*), has been eliminated in the wild as a result of poisoning and shooting campaigns. At least 130 grassland species are associated with prairie dog towns (Godbey and Biggins 1994), and up to 170 vertebrate species have been seen in these towns.

Another complaint of cattlemen, that cattle fall into prairie dog burrows and break their legs, has also been refuted. Don Sharps, a wildlife consultant, asked an audience of 200 ranchers if any of them knew of a case of a horse or cow that had broken its leg in a prairie dog town, and no one said yes (Dold 1998). Such prejudices are passed down from generation to generation and fuel the persecution programs against these ecologically important rodents.

Slow-acting poisons, such as zinc phosphide, are used by many animal damage control programs. This chemical takes up to 12 hours to kill prairie dogs, who suffer extremely painful deaths (Wuerthner 1996). Another technique is the placement of gas cartridges in prairie dog burrows. These are ignited and burn the prairie dogs alive (Wuerthner 1996). On federal lands, these programs are conducted by the Wildlife Services unit of the Department of Agriculture at public expense. In the 1980s, more than $6 million was spent to eradicate 460,000 acres of dog towns on the Pine Ridge Indian Reservation in South Dakota (Line 1997). This was the largest remaining prairie dog town in the United States (Dold 1998) and the site of the only population of Black-footed Ferrets known to exist in the 1970s. In 1993, Animal Damage Control (now called fiWildlife Servicesfl) used, sold or distributed 220,000 fumitoxin tablets, 60,000 gas cartridges, and 21,000 pounds of zinc phosphate baits in the northern plains states to eradicate prairie dogs (Wuerthner 1996).

Studies about prairie dogs have revealed them to be surprisingly intelligent. They communicate in yips and chirps, some of which are warnings to other members of the town. A study by Professor Con Slobodchikoff of Northern Arizona University has revealed that prairie dogs™ calls convey specific information, such as what size a predator is, what type of animal, its speed of travel and level of threat (Dold 1998). Slobodchikoff created experiments in which two people walked through a prairie dog town that had experienced hunting; one carried a simulated rifle, while the other did not. The prairie dogs gave different calls for each person, and when the "hunter" returned in a few weeks without his rifle, they still gave the call for a man carrying a rifle (Dold 1998). Such communication goes far beyond what most people consider rodents to be capable of and shows their ability to react to a variety of threats, including the most serious one, human beings. Unfortunately, their warnings could not protect them from poison, shooting, and even bulldozing of their burrows.

Knowledge about the true role that prairie dogs play in grassland ecosystems has yet to reach most ranchers and others who have a hatred for these rodents that seems to reach no bounds. Many compare notes on how many prairie dogs they have killed, usually by high-powered bullets that cause them to disintegrate on contact (Long 1998). One group in eastern Colorado with 30 members calls themselves the Varmint Militia and kills prairie dogs as a sport. They recently spent two full days shooting prairie dogs until activity in the prairie dog town slowed (Long 1998). One militiaman bragged of having shot 20,000 prairie dogs and wants to retire from his exterminating business to shoot them full time (Long 1998). These shooters recount with glee the story of a recent protest. Some animal rights protesters tried to stop one of these hunts and chained themselves together, refusing to move; the Varmint Militia called the Kit Carson County sheriff, who placed them in jail for the weekend (Long 1998).

Although private shooting may be difficult to stop, many biologists and conservationists have recommended that all government poisoning and shooting on public land be halted and that subsidies be offered to ranchers who do not kill prairie dogs on their property (DeBlieu 1993). Unfortunately, no action has been taken in this direction.

Sport hunting of these rodents is encouraged by state game departments, and many towns organize hunts as a form of recreation. These hunts, which often involve the killing of hundreds of prairie dogs in a single afternoon, are taking a

high toll of these declining animals in many areas (Wuerthner 1996). A South Dakota organization, Varmint Hunters Association, brags that its 45,000 members do society a favor by killing prairie dogs. The vice president, Marc Minkin, told a reporter, "I'd like to be able to step out my back door in the morning and take a couple of shots before my morning coffee" (Dold 1998). The organized prairie dog shoots draw "hunters" from around the country; one hunt held in Nucla, Colorado, obliterated an entire town (Dold 1998). This hunt, which involves taking pot shots at prairie dogs emerging from their burrows, which they must do to feed, is totally unsportsmanlike--a virtual slaughter.

Even in national parks, poisoning takes place as a result of pressure from neighboring ranchers. In spite of abundant habitat in Theodore Roosevelt National Park, Badlands National Park, Wind Cave National Park and various national monuments in the Great Plains, only 6,000 acres of prairie dog towns have been protected (Wuerthner 1996). In most cases, park authorities have been threatened with lawsuits unless they poison prairie dogs. In South Dakota, home of Badlands National Park, a prime potential area for reintroduction of the endangered Black-footed Ferret, the state has declared prairie dogs to be noxious pests and mandates their control (Long 1998). At Devils Tower National Monument in Wyoming, the park rangers use rifles and poison to thin the ranks of its prairie dog colony (Long 1998).

Increasingly, development in the form of housing complexes, malls, highways and industrial centers, has gobbled up millions of acres of land in the West, much of it inhabited by prairie dogs. Some developers merely bulldoze the towns, while others pay to have a company use a giant vacuum cleaner that sucks prairie dogs out of the ground amid deafening noise similar to that of a jet airplane taking off. The proud inventor of this machine bragged that it was non-lethal, and the rodents could then be killed humanely or otherwise disposed of to allow development programs to proceed. In fact, most of the prairie dogs taken in this manner are killed or injured in the process (Dold 1998). The trauma involved for the prairie dogs must be extreme. Many of the prairie dogs removed from their burrows have been offered for sale as pets, advertised in eastern newspapers. Although loveable and cute, these animals are not suitable house pets because they are wild rodents who require extensive dirt to burrow in. They cannot adjust to the unnatural environment of a home. Unfortunately, this new invention has been given favorable publicity in the media. The majority of prairie dogs that survive this operation end up as pet food, according to CNN (December 15, 1996).

A more humane program involves the moving of prairie dogs to safer environments. A Colorado organization, Prairie Ecosystem Conservation Alliance, hoses prairie dog burrows with water and a biodegradable dish soap that creates frothy suds below ground. The suds irritate the eyes of the prairie dogs, who come to the surface where members of the Alliance are waiting to scoop them up and place them in carriers. They then truck them to a safe area, preferably one with empty burrows, and release them (Dold 1998). An even better solution is to save the towns, since the latter method will not save all the other animals inhabiting the burrows. The city of Boulder, Colorado, became the first town in the state to officially designate land to protect prairie dogs. In 1987 it set aside a preserve for prairie dogs, which now covers almost 5,000 acres (Dold 1998). Fort Collins, further north, began with a reserve of 268 acres and now has 1,700 acres (Dold 1998).

A Native American Gros Ventre tribesman, Mike Fox, has come full circle, from sponsoring prairie dog shoots on the Fort Belknap Indian Reservation in Montana to understanding their positive effect on grasslands by watching Bison graze near the towns on the "best grass around" (Long 1998). There are 400 American Bison on the reservation, and Fox, who manages the reservation's wildlife program, has sharply curtailed prairie dog shooting and accepted 23 Black-footed Ferrets to be reintroduced into the 500,000 acres of prairie on the reservation (Long 1998). He tells Indian ranchers, who still kill prairie dogs, that these animals were here before, and the ferret is not a new animal, but an old one returning (Long 1998).

All but 2 percent of original prairie dog populations are now gone, having been poisoned out to make way for livestock or agriculture. The majority of remaining towns are still unprotected, and the poisoning continues. Grasslands with prairie dogs support far higher densities of mammals, birds and other wildlife than those without them.

Several prairie dog species have been driven to near extinction. The Utah Prairie Dog (*Cynomys parvidens*), native to

south-central Utah, became endangered from these programs and the loss of habitat to livestock and agriculture. Listed on the US Endangered Species Act, this species has a restricted range in southwest Utah, and after poisoning programs, its population fell from an estimated 95,000 animals in 1920 to only 3,300 in 1972 (Nowak 1999). Through protection accorded by the US Endangered Species Act, Utah Prairie Dogs began to rebound, and by 1984, the species was downgraded from Endangered to Threatened on the US Endangered Species Act. Populations of prairie dogs fluctuate widely, and counts of Utah Prairie Dogs in the early 1990s ranged from 6,400 in the fall to 24,000 after they had pups in the spring (Nowak 1999). The species has recovered somewhat overall, mainly as a result of the Fish and Wildlife Service program of transplanting prairie dogs from private to public lands (Turbak 1993). Initially, many of the released prairie dogs failed to survive, and not until they began releasing males in the spring, who industriously spent the summer excavating burrows to accommodate other prairie dogs released in the fall, did transplants succeed (Turbak 1993). Utah Prairie Dogs hibernate each winter in compartments in the complex maze of their underground tunnels.

Although some Utah Prairie Dogs have been placed on public land, 60 percent of them still live on private land, where special US Endangered Species Act regulations allow farmers and ranchers to shoot or trap an annual quota of prairie dogs; a high of 6,000 were killed one year, and in 1992, 1,543 were killed (Turbak 1993). Education campaigns and tax incentives to protect prairie dog towns would be far preferable to quota systems.

Mexican Prairie Dogs (*Cynomys mexicanus*) of southern Coahuila and northern San Luis Potos, Mexico, have declined as their habitat has been converted to agriculture and grazing land for livestock, and many colonies were exterminated by poisoning. The largest remaining town covers only 4,400 hectares (Nowak 1999). The species is listed as Endangered by the US Endangered Species Act as well as by the *2000 IUCN Red List of Threatened Species*.

A third species, the Black-tailed Prairie Dog (*Cynomys ludovicianus*) has declined by 98 to 99 percent (Wuerthner 1996) in a range which once extended from Montana and southern Saskatchewan to northern Mexico (Nowak 1999). The Biodiversity Legal Foundation in Colorado filed a petition in October 1994 to list it as a Category 2 species under the US Endangered Species Act, a category just below Threatened. Although the Fish and Wildlife Service's own biologists supported this listing, the petition was denied after political pressure from ranchers (Wuerthner 1996).

Thus, at least three of North America's five species of prairie dogs are in grave danger of extinction, and the remaining two have declined precipitously. Their ecosystems are threatened as well, as are many of the species that depend on them. Although they are extremely photogenic and likeable, prairie dogs are not ecotourist attractions at present. With protection and more publicity, such as nature films and education programs, they could become so, and this would enhance their conservation.

Conservationists have proposed some huge reserves for prairie dogs that would link remnant populations in parts of the West, where much of the land is now under the control of the Bureau of Land Management of the Department of the Interior. The latter department favors cattle ranchers more than prairie dogs, but with outside pressure and publicity, such a plan might become reality. The Fish and Wildlife Service has had difficulty locating prairie dog towns that are protected from poison programs in which to reintroduce captive-bred Black-footed Ferrets.

For their long-term survival, prairie dogs need extremely large territories. At present, fragmented populations, which are often reduced to a few hundred animals widely separated from the nearest prairie dog town, have lost viability from lack of genetic interchange, and some scientists fear that their natural behavior may be altered by this isolation. These loveable animals need more friends to speak out on their behalf and demand that they be protected from poisoning, "sport" hunting and other persecutions, and that sanctuaries be established.

Economically, they may be worth far more alive than dead. The potential for using prairie dogs as a focal point for ecotourism is great. Tourists would be delighted by their behavior and fascinated to see the rich wildlife that inhabits their towns.

Trophy and Sport Hunting
During the late 19th and early 20th centuries, wealthy European and American big game hunters traveled to Asia, Africa and South America to "bag" large animals that they proudly displayed as stuffed animals and heads mounted on the walls of their homes. Maharajahs of India and British hunters took what Vincenz Ziswiler (1967), in his interesting book, *Extinct and Vanishing Animals*, describes as "a morbid pleasure in killing." Lord Ripon, an Englishman who died in 1923, was credited with killing 500,000 game birds and mammals--about 67 creatures for every shooting day of his life (McClung 1976).

One maharajah turned away from hunting and became a famous conservationist. Brajendra Singh, the last Maharajah of Bharatpur, hosted hundreds of hunts on his estate at the Keolada Ghana marsh 100 miles south of Delhi. A shoot organized by an English lord resulted in the killing of 4,323 ducks by 39 hunters in one day. In 1970, Brajendra Singh converted the duck shoot marsh into India's best known bird sanctuary. Singh died in 1995, having presided over the preservation of this vast marsh and its rare resident birds.

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Trophy and Sport Hunting: Page 1
The most prestigious trophy for maharajahs and colonial hunters was the Tiger (*Panthera tigris*), largest of all cats. One maharajah shot at least 1,000 Tigers in his lifetime, while another complained that his total bag of Tigers was only 1,150 (McClung 1976). The number of Tigers killed by these two maharajahs equaled the entire population of these cats in India by the late 1960s. Tiger hunts were a royal pastime and employed hundreds of native "beaters," who drove the frightened cat toward a hunter who was perched safely atop an elephant.

Tigers require large territories. Even in the best habitats, their natural density is low. They probably once numbered 50,000 in India alone, however, when forests covered much of the country. Tigers were hunted to extinction on the Indonesian islands of Java and Bali, where each was a separate subspecies, and they have been hunted to endangered status on Sumatra. In the western portion of their range, the Anatolian or Caspian Tiger (*Panthera tigris virgata*) once ranged from Turkey eastward through the Caspian Sea region of Central Asia. Hunting eliminated these Tigers in Central Asia centuries ago, and only a few isolated populations remained in Turkey by 1900. The last individuals in Turkey were shot in 1972. This subspecies was driven to extinction by trophy hunting and persecution by livestock owners. By the 1960s, Indian Tigers were endangered, yet trophy hunting and killing by livestock herders for the fur trade continued. Indian President Indira Ghandi established a conservation program called Project Tiger in the 1970s, which set aside many reserves and accorded strong legal protection. When the species was beginning to increase in numbers, a trade in their body parts for Traditional Chinese Medicine reversed this recovery.

Today, fewer than 5,000 Tigers remain in the wild. At the present rate of killing--one Tiger per day--the species will become extinct in the wild within 30 years or less. Hunting of these magnificent cats intensified in the 1980s and has accelerated everywhere. They are killed by poison, traps and guns wherever they survive. Villagers and professional

hunters sell Tiger pelts, bones and other body parts in a network of smugglers that reaches from rural India, Bangladesh and Indochina to China, Japan and Taiwan. Tiger pelts are openly sold as trophies in many Asian countries, including Pakistan, Cambodia and Vietnam. They are displayed on shop walls, often with head attached. Some Tiger cubs are even part of this trade, killed and stuffed to be sold as tiny curios.

This magnificent cat will not survive long without legions of rangers guarding the remaining animals. Anti-poaching funding is inadequate in almost all its range. Indian parks and sanctuaries, many of them set aside for the Tiger, are understaffed, and dedicated wildlife wardens are underpaid and poorly equipped to combat poachers (Currey 1996). Some Indian park wardens have been bribed by poachers and watch as they skin dead Tigers (Breeden and Wright 1996). Elsewhere in the Tiger's range in Thailand, Cambodia and Burma, for example, few parks and protected areas have been set aside, and wildlife conservation has low priority.

The market for the pelts and stuffed trophies of these last Tigers among wealthy status-seekers in Asia and elsewhere has increased in recent years. One Taiwanese businessman profiled in a *National Geographic* article (Zich 1993) proudly displayed three stuffed Tigers which he had placed in his bedroom; one of the Tigers was standing on a Lion pelt with the head attached. He protested, "I worked so hard to make money. Now I spend it" (Zich 1993).

In spite of what appear to be overwhelming odds, new projects are attempting to turn the tide. Anti-poaching work in Siberia has helped arrest the steep decline of this critically endangered race of the Tiger in a joint United States-Russian program (Galster 1996). An international fund begun by Exxon Corporation, whose logo is a Tiger, has sponsored anti-poaching work and research throughout its range as well as education programs to persuade Asians not to purchase Tiger products. The US Congress appropriated several million dollars for anti-poaching campaigns, and organizations, such as the Wildlife Conservation Society based in New York City, have worked in Cambodia, Indonesia and other countries to survey and aid in conservation of the species. Scientists have cooperated in studies of the Tiger and aided governments in conservation programs, as described in the recent book, *Riding the Tiger. Tiger Conservation in Human-dominated Landscapes* (Seidensticker *et al*. 1999).

The Asiatic Cheetah (*Acinonyx jubatus venaticus*) once occurred throughout the Middle East as far as India. In the 16th century, the Indian emperor Akbar the Great kept more than 1,000 Cheetahs for hunting. Only one litter was produced by his Cheetahs, and the species died out in India and all of its Asian range except Iran, where fewer then 200 animals remain (Hunter 1998). It is classified as Critical, the most endangered category by the *2000 IUCN Red List of Threatened Species*. The Northwest African Cheetah (*Acinonys jubatus hecki*) is listed as Endangered by the IUCN. In reality, it is nearly extinct, with possible survival only in Algeria, Morocco and Niger, having disappeared from Egypt, Libya and Western Sahara. In the Saharan region, nomadic tribes, such as the Tuareg and Toubou, hunt Cheetah in desert areas of Mali, Niger and Chad, using saluki dogs (Hunter 1998). On occasion, Cheetah prey on young camels in the area, their natural prey having been eliminated. The tribes have such a hatred for Cheetah that they pursue them if they see their tracks, with or without proof of predation (Hunter 1998). Being followed for days in the extreme heat, the Cheetahs sometimes die from heat and stress even before the men and dogs reach them (Hunter 1998).

Trophy and Sport Hunting: Page 2

In the stark deserts of the Saudi Arabian Peninsula and the Mideast, wildlife is not abundant. Animals struggle just to survive in the harsh environment. A wild desert equine became a casualty of unrestricted hunting after World War I. The Syrian Wild Ass (*Equus hemionus hemippus*) was hunted to extinction for sport and meat. These wild asses had been hunted out of most of their original range by the 19th century, but in 1850, they were still seen commonly in large herds in the region once known as Mesopotamia, between the Tigris and Euphrates Rivers. Perfectly adapted to the searing desert heat and sparse vegetation, they ran from natural predators at great speed, and their sand-brown

coloration camouflaged them. After thousands of years of adaptation and survival, these delicately hued wild asses found themselves shot at by 20th century soldiers and other hunters. World War I troops and later, civilians in all-terrain vehicles, chased them at high speeds, killing entire herds of these equines for "sport." With no natural cover and unable to outrun jeeps, entire herds were slaughtered. The last known Syrian Wild Ass was shot in 1927 as it came down for water at the Al Ghams oasis in northern Arabia (Day 1981). The surviving populations of this species, the Asian Wild Ass (*Equus hemionus*), are listed as Endangered by the US Endangered Species Act.

After World War II, Arab sheikhs began hunting Arabian Oryx (*Oryx leucoryx*), Arabian Gazelles (*Gazella arabica*) and Arabian Ostrich (*Struthio camelus syriacus*) in all-terrain vehicles and trucks, mowing them down with repeating rifles, shotguns and even machine guns. These macabre and senseless hunts even involved the use of planes and helicopters for spotting. Sometimes animals were pursued until they dropped dead from exhaustion. In 1955, some 482 cars took part in a hunt during the course of a "royal goodwill tour" in northern Saudi Arabia, and every living animal seen was gunned down (McClung 1976). The Arabian Ostrich formerly ranged from Syria to the Arabian Peninsula, and it became a casualty of these forays. The last wild Ostrich was killed and eaten by Arabs near the Trans-Arab oil pipeline north of Bahrain between 1940 and 1945 (Greenway 1967).

The Arabian Oryx nearly followed the Ostrich into extinction when the last three individuals left in the wild were killed off in 1972 in southern Oman (IUCN 1978). This statuesque white antelope, with long, curved horns that arch over its back, once inhabited a wide range in the Middle East, from Syria and Israel to the Arabian Peninsula (Nowak 1999). It was saved from extinction by actions of the Fauna Preservation Society, headquartered in England, and the IUCN, which had undertaken an expedition in 1962 to capture some of the last wild Arabian Oryx for captive breeding. In eastern Aden, four oryx had been taken into captivity, and this herd was augmented from private game farms and zoos by another eight animals, which were transported to the Phoenix Zoo in Arizona. They adjusted easily to the desert climate of the American Southwest and soon bred in captivity. This herd has grown, and several zoos now breed them. Some of these stately animals have been reintroduced successfully into preserves in Oman and other parts of their original range. They have been studied by field biologists who have found that they reverted to wild behavior, with females in separate herds, and males solitary or in bachelor herds defending territories (Nowak 1999). Eighteen breeding herds occupied 14,121 square kilometers in Oman in two 1988 studies (Nowak 1999). In 1990, more Arabian Oryx were reintroduced into Saudi Arabia. There are now about 500 of these oryx in the wild and an additional 300 in captivity on the Arabian peninsula; 2,000 are held in zoos (Nowak 1999). For many Arab conservationists, the return of the Arabian Oryx has been an important event because this species has been very important to the cultures of the Arabian Peninsula for thousands of years. The reintroduced oryx have been guarded zealously to prevent another tragic disappearance.

Gazelles of dryland and open country were at one time abundant throughout North Africa and the Middle East, able to survive in the hottest and dryest of deserts. People have long hunted them for food, and there is little cover where they can hide. In ancient times, stone corrals were constructed into which gazelles were driven for slaughter, and until the early 20th century, these were still in use (Nowak 1999). Some Arab hunters still use captive and trained falcons to harass gazelles in order to frighten and confuse them so they can then be chased down by dogs (Nowak 1999). Two of these small and dainty ungulates have been hunted to extinction, and others have become very rare throughout the region. The Antelope Specialist Group of the IUCN lists the Saudi Gazelle (*Gazella saudiya*) as extinct in the wild and the Queen of Sheba's Gazelle (*Gazella bilkis*) of Saudi Arabia as extinct, with no captive populations. Until the 1990s, the latter species had been classified as Endangered. But the *2000 IUCN Red List of Threatened Species* reports that this delicate animal, which was considered very common in 1951, has not been seen in decades. A survey in 1992 in its range in mountains near Ta'izz failed to find any of these gazelles.

The *2000 IUCN Red List of Threatened Species* categorizes many other gazelles of the region as Threatened and Endangered. The Arabian Gazelle (*Gazella gazella*), native to the Arabian Peninsula, Israel and Palestine, is classified as Conservation Dependent, a category indicating that without strict protection it would decline to Threatened status. Five subspecies of this gazelle are listed in various categories, the most endangered being the Palestine Mountain Gazelle (*Gazella gazella gazella*) (Conservation Dependent) and the Acacia Gazelle (*Gazella gazella acaciae*)

(Critical) of Israel, and the Muscat Gazelle (*Gazella gazella muscatensis*) (Critical) of Oman. Another threatened gazelle is the Arabian Sand Gazelle (*Gazella subgutturosa marica*) (Vulnerable). These little Mideastern gazelles have been heavily persecuted and hunted. Added to the hunting, which is not well controlled, the Arabian Peninsula and much of Israel and Palestine have been heavily overgrazed by livestock, and the scarce oases are used for agriculture and livestock, leaving little natural vegetation for wildlife.

Reintroduced gazelles in Israel's Golan Heights increased to about 4,000 in the late 1980s, and government officials decided to allow the hunting of 2,000 of them by Arabs, who shot to wound rather than kill so that the animals could be killed ritually through throat slitting. This hunt, filmed by Afikim Productions and Survival Anglia in 1990, was a gruesome sight of crippled and dazed gazelles, stumbling about after the shooting.

The most avidly pursued animal by Arab sheikhs is undoubtedly the Houbara Bustard (*Chlamydotis undulata*). The meat of this large, long-legged bird of scrubby desert and sandy grasslands is considered an aphrodisiac by Arabs, although in fact it is a mild diuretic (Weaver 1992). It has been hunted relentlessly on the Arabian Peninsula, causing many populations to disappear. Arab sheikhs have hunted these birds for centuries using a trained falcon that catches the bird as it flies to escape. The great oil wealth accumulated by sheikhs of Saudi Arabia, Qatar, Bahrain, Kuwait and the United Arab Emirates has allowed them to indulge in this "sport" in a manner befitting the bejeweled and pampered rulers of ancient kingdoms. With these bustards so rare on the Arabian Peninsula, they now hunt them in Pakistan. Traditionally, the sheikhs used camels as transport, but today they drive in fleets of 60 or 70 customized all-terrain vehicles, careening through the desert at speeds up to 80 miles per hour, flattening the landscape, vegetation and small animals under their wheels (Weaver 1992). Armed with high-powered guns to shoot any animal that comes into view, the sheikh occupies an elevated seat that swivels 180 degrees to enable him to spot the Houbara Bustards and their tracks in the sand (Weaver 1992). The ecological damage done by the armies of vehicles that flatten vegetation, scar the landscape, and slaughter every animal they see is so severe that it may result in the local extinctions of many rare and delicate species of the Pakistani desert (Hoyo *et al*. 1996).

Many Houbara Bustards winter in Pakistan, converging from breeding areas in Kazakhstan and other countries in the region. Their breeding range extends to North Africa east across Asia to China. In Pakistan and 23 other countries, including India, Iran and Russia, the Houbara Bustard is totally protected from hunting (Weaver 1992). Yet by means of lavish gifts and payments to high government officials and landowners, wealthy Arabs have received special dispensation to pursue and kill thousands of these birds, which are considered endangered and declining in many parts of their range, especially in North Africa, Bahrain, Jordan, Iran, Iraq and India (Hoyo *et al*. 1996, BI 2000).

These extraordinary birds present a spectacular show with their elaborate courtship, strutting and displaying beautiful white puffs of head and body feathers.* Some hunting, mainly illegal, also occurs in their breeding grounds, which greatly disrupts their courtship, nesting and care of chicks.

*"Red Desert," a film in the series fiRealms of the Russian Bearfl described in the Video section, shows these birds displaying and hunting lizards.

The hunts have been carried on for decades in Pakistan, and Houbara Bustards have declined steadily as a result. As early as 1983, scientists and conservationists at a symposium on bustards convened by the International Council for Bird Preservation (now BirdLife International) unanimously called for a five-year ban on hunting (Weaver 1992). Although Pakistan's President at that time supported the symposium, he ignored the appeal and, the following year, allowed 25 parties from the Saudi Arabian Peninsula to hunt; they killed more than 5,000 Houbara Bustards (AWI 1985). Since that time, hunts have continued in spite of changes in administration in Pakistan, and although Arab hunters realize that these birds are heading toward extinction, they have not decreased their kills or practiced conservation. Moreover, they are now hunting in new areas, close to breeding grounds (BI 2000).

One sheikh, the cousin of the ruler of Dubai, found no Houbaras in the tract where he had arranged to hunt. He then moved his camp into Kirthar National Park, where he illegally killed more than 200 Houbaras in 10 days, along with

protected gazelles and ibex (Weaver 1992). As recently as the 1960s, Houbara Bustards were so numerous in Pakistan that they could be counted "like butterflies in a field," but by the 1990s, they became scarce in many areas, and their populations have experienced sharp downward trends (Weaver 1992). No restrictions are placed on the take of Houbaras by the visiting sheikhs.

Some Pakistani conservationists have fought the illegal arrangements made between the Arabs and government officials, and the Society for Conservation and Protection of the Environment (SCOPE), took the issue to the Sind High Court, which ruled in their favor (Weaver 1992). However, because Pakistani government officials rarely follow such provincial court decisions, the hunt did not end. When asked why the government has done so little to protect its wildlife, a well-known Pakistani environmentalist, Wahajuddin Ahmed Kermani, the retired Inspector General of Forests, replied, "Because we lack the moral fibre and the moral courage" (Weaver 1992).

Protests from conservationists in Europe and elsewhere have had no real effect either. Paul Goriup, the bustard expert at BirdLife International in Cambridge, United Kingdom, believes that populations of Houbara Bustards in Sind and Punjab provinces of Pakistan have become "terribly diminished," and hunting of breeding populations has a disastrous effect (Weaver 1992). Goriup contends that the species must be protected by the United Nations' Bonn Convention on Migratory Species to bring the issue to an international level (Weaver 1992). The Houbara Bustard is listed on Appendix I of CITES, which bans all commercial trade between member nations. Yet each year, 500 or more eggs, chicks and adult Houbaras are smuggled from Pakistan, a CITES member, by sheikhs who use them to train their falcons and for captive-breeding programs of dubious effectiveness. Abrar Mirza, the wildlife conservator for the Province of Sind, confiscates many such shipments, but most provincial wildlife officials merely look the other way, especially after receiving diamond-studded, gold Rolex watches and other such gifts from the Arabs (Weaver 1992). The confiscation of so many Appendix I birds in the United States would result in severe penalties, including possible jail sentences, but the effectiveness of CITES depends on the legislation each member country enacts to enforce it and the zeal with which these laws are enforced.

Sheikhs from the United Arab Emirates (UAE) were not so well-received in Turkmenistan in 1995 when they applied to the Ministry of Foreign Affairs to hunt Houbara Bustards. This Ministry forwarded the request to the Ministry of Nature Use which, quite unexpectedly, turned it down because the birds would be breeding (Zatoka 1995). Certain that they would be able to overcome this opposition, the sheikhs arrived in Turkmenistan ready to hunt without official approval, bringing their falcons (Zakota 1995). To their amazement, they were issued an official complaint by the Director of the Department for Animal Conservation and fined $40,000 (Zakota 1995). The sheikhs then turned to Turkmenistan's President Niyaziv, confident that they would be able to overturn the decisions of the wildlife department; instead, he backed up the decision of the Ministry of Nature Use, stating that it had jurisdiction in this issue (Zakota 1995). This was an extremely important precedent and a fine example of a country according its wildlife the respect and protection it deserves. Turkmenistan has a record of combating poaching and conducting environmental research and conservation programs (Zakota 1995).

One sheikh has renounced hunting and fostered environmental programs. Sheikh Zayed of the United Arab Emirates, while hunting gazelles with a rifle, realized that this amounted to "an outright attack on animals" and a cause for their possible extinction (Morgan 1998). He then began a program of setting tracts of land aside for wildlife and setting up breeding herds of endangered oryx, gazelles and other desert ungulates on an island off the coast (Morgan 1998). Other UAE sheikhs have obtained special favors when hunting on the African continent. The government of Tanzania granted exclusive hunting rights in one of the country's most important wildlife areas to a high-ranking official from UAE (Alexander 1993). The agreement was reached in secret with the Deputy Minister of Defense of that country, and he apparently has been allowed to hunt endangered species, such as Cheetah, with automatic weapons (Alexander 1993). The influence of wealthy Arabs in bending wildlife laws has reached to many corners of the world. One of their prime targets is North America for its beautiful Gyrfalcons (*Falco rusticolus*), listed on CITES Appendix I, one of the most coveted of all birds of prey for falconry. Their attempts at bribery, often successful, to obtain these protected birds from Canada resulted in the listing of this species on CITES to prevent any further commercialization of these birds, which was causing declines in their wild populations.

Trophy and Sport Hunting: Page 3
The vast Sahara has been the scene of similar hunts. Scimitar-horned Oryx (*Oryx dammah*) originally had a wide range in arid grasslands from Morocco and Senegal east to Egypt and the Sudan. In historic times, herds of 100 animals were commonly seen, and during wet season migrations, they traveled in groups of 1,000 animals or more. Their white and brown coloration allowed them to blend into the desert, and they were admired for their extremely long, back-curving horns. Their populations and range gradually shrank with hunting, overgrazing and agricultural encroachment on natural grasslands; the species disappeared from Egypt and Senegal in the 1850s. In the 1970s there were still an estimated 6,000 of these spectacular animals in the southern Sahara (Nowak 1999). The Haddad tribe of northern Chad centered their way of life around hunting these oryx, driving them into nets and killing them for their meat (Simon 1995).

Although traditional hunting made inroads into Scimitar-horned Oryx populations, the use of four-wheel-drive vehicles and modern firearms by prospectors and military personnel within the past 30 years drove the species to near extinction (Simon 1995). Groups of wealthy Middle Eastern hunters arrived with all-terrain vehicles and automatic rifles, eliminating these animals from most of their range. Chad's Ouadi Rime-Ouadi Achim Faunal Reserve became one of their only refuges by the 1970s, but the outbreak of war between that government's forces and Libyan-backed rebels in 1978 brought about an unregulated slaughter of the last population of Scimitar-horned Oryx within the reserve, reducing them to only a few hundred animals (Simon 1995). In an attempt to reintroduce these majestic antelope to their original range, 41 were captured in western Chad in 1966 and placed in captivity (Simon 1995). Some 500 of these oryx are part of the American Zoo Association's Species Survival Plan, and another 700 are in other zoos; an unknown number are in ranched herds, especially in Texas (Nowak 1999). A small number of Scimitar-horned Oryx were released into a national park in Tunisia in 1991 (Simon 1995), and others may be released in Niger (Nowak 1999). The IUCN listed this species as Critical in 1996, Extinct in Algeria, Egypt, Libya, Mauritania, Senegal, and Western Sahara, and Probably Extinct in Burkina Faso, Chad, Mali, Niger, and Sudan. The *2000 IUCN Red List of Threatened Species* listed the Scimitar-horned Oryx as Extinct in the wild.

The Addax (*Addax nasomaculatus*), a desert antelope which once ranged from Western Sahara and Mauritania to Egypt and Sudan, is now nearly extinct in the wild as a result of heavy hunting combined with loss of its grassland and shrubland habitat to agriculture and competition with livestock. Perfectly adapted to life in the desert, Addax are able to spend their lives without drinking water, deriving moisture from plants on which they feed (Nowak 1999). Instead of the long, arched horns of the Scimitar-horned Oryx, the Addax has horns that grow outward, then bend inward and upward. A stocky antelope that is not able to run quickly enough to flee men on horses, it has been easy prey for hunters and feral dogs. In recent years, remnant populations literally have been run to death by tourists in four-wheel-drive vehicles who pursue them until the animals fall dead in the sand (Nowak 1999). A herd in northeastern Niger was reduced to 50 to 200 animals when, according to some reports, they were wiped out by hunting. Fewer than 200 remained in north-central Chad, and another 50 along the border of Mali and eastern Mauritania in 1994 (Nowak 1999). The *1996 IUCN Red List of Threatened Animals* listed the Addax as Endangered, Extinct in Algeria, Egypt, Libya, and probably Sudan. The *2000 IUCN Red List of Threatened Species* upgraded its status to Critical. A small reintroduced population survives in Tunisia, but the wild population is at risk of disappearing altogether. More than 400 animals are in captivity, including a herd in a large dryland safari park in Texas called Fossil Rim.

Other Saharan animals have been ruthlessly pursued. Pelzeln's Gazelle (*Gazella dorcas pelzelni*) have been pushed to Vulnerable status by hunting. They are listed on the US Endangered Species Act. The Slender-horned Gazelle (*Gazella leptoceros*), native to North Africa, is now endangered throughout its range, according to the *2000 IUCN Red List of Threatened Species*. The hunting of these desert animals by men in all-terrain vehicles, some armed with

machine guns, reached such heights in the 1970s that they nearly became extinct, and their status has not improved in the intervening years. The endangered Dama Gazelle (*Gazella dama*), also a heavily hunted species, is extinct in Algeria, Libya, Mauritania, Morocco and Western Sahara; it has been reintroduced into Senegal, and populations are now confined to Chad, Mali, Niger and Sudan (Baillie and Groombridge 1996). Cuvier's Gazelle (*Gazella cuvieri*), another North African species, is also extinct in the Western Sahara and survives in endangered populations in Algeria, Morocco and Tunisia, according to the IUCN. In some cases, antelope and gazelles have been pursued by hunters in helicopters who shoot at them with rockets, a method also used to kill African Elephants in Chad, where the last Greater Kudus (*Tragelaphus strepsiceros*) were destroyed in 1976 (Anon. 1977).

Trophy and Sport Hunting: Page 4

Poachers have caused the extinction in Somalia of the endangered Hunter's Hartebeest or Hirola (*Damaliscus hunteri*), which now survives only in a restricted portion of scrubby desert of south-eastern Kenya. Looking somewhat like an Impala, this delicate, dryland antelope can live for weeks on very little water. This species is considered an evolutionary relic, having lived on earth for 15 million years, and is a progenitor of other hartebeests and the Topi; fossil evidence indicates that the Hirola's range once extended to South Africa (McKinley 1996). Kenyan populations totaled 14,000 in 1976, living along the Tana River and in the arid Garissa region to the east (McKinley 1996). In the 1980s, poachers killed off the region's African Elephants, who had kept the land clear of thorn bushes for grazers, such as the Hirola (McKinley 1996). A rinderpest epidemic brought in by cattle herders wiped out half the region's antelope between 1983 and 1985.

In the early 1990s, Somali refugees and troops fleeing from civil war in Somalia crossed into Kenya and began slaughtering the Hirola (McKinley 1996). By 1993, only 2,000 Hirola survived, and with unregulated hunting, a 1995 census found a total of 306 animals scattered in small groups over 45,000 square miles (McKinley 1996). Rangers from the Kenya Wildlife Service decided to capture and move as many as possible of the remaining animals to Tsavo National Park, where they could be guarded against illegal hunting. One hundred animals were moved to the park in 1995, and a year later, about 57 survived. In 1996, more were chased by helicopter into nets, sedated, blindfolded, and then taken by truck to a small plane which airlifted them to Tsavo. The habitat in Tsavo is lusher and greener than their native desert shrub, and the Hirola may not thrive there. Only time will tell. The *2000 IUCN Red List of Threatened Species* lists the species as Critical.

Trophy and Sport Hunting: Page 5

In South Africa, the Quagga (*Equus quagga*), a zebra-like equine, became extinct from hunting. Some zoologists consider these animals to have been a race of Burchell's Zebra (*Equus burchelli*), but others classify them as a full species. They had black, vertical stripes on the head and neck, while their back and haunches were uniform grayish or faintly striped. Native to the Cape Colony grassy plains, their limited and open habitat made them vulnerable to the Boer settlers, who killed them by the thousands (Day 1981). Many were tamed and used to guard domestic livestock at night because they gave loud alarm calls upon seeing predators (Day 1981). Some were even shipped to London and used as harness animals. The Boers used their skins for sacks and other practical purposes. By the 1850s, it had nearly disappeared from the Orange River area from relentless hunting (Nowak 1999). The last wild Quagga was killed in 1878, and in 1883, the last captive Quagga died in the Amsterdam Zoo (Day 1981). Photographs (Nowak 1999) and specimen skins exist with DNA that has been compared with living zebras. There has been talk of restoring a Quagga-like animal through selective breeding with Plains Zebras.

Many other South African species were reduced to endangered status or eliminated from the country altogether by

Boer hunting and their policy of clearing the land for livestock and agriculture. Although many parks have been set aside, wildlife as a whole has been crowded out of its natural environments in South Africa. Elephants became restricted to an area in the northeast that later became Kruger National Park, and only recently have they been reintroduced into a few parks elsewhere. Zebras have become extremely rare, with several races critically endangered (see Grasslands, Shrublands and Deserts chapter).

The high-altitude Simien Mountains National Park (6,234 to 14,535 feet) has many endangered endemics. A Survival Anglia film, fiEdge of the Abyss,fl records many of these species, including the Walia Ibex (*Capra walie*), a mountain goat found only in Ethiopia. It has a population of about 300 in the park and stays above 10,000 feet, browsing in the giant heath. These goats were common until the 1930s when hunting decimated their numbers. They also have lost habitat to agriculture and livestock. By the 1960s, there were only 200 Walia Ibex in the park, and although they have recovered somewhat, they still are poached for their magnificent, massive curved horns, hides and meat. Poachers enter the park and place nooses on the narrow mountain trails they must use to travel from one part of the park to another.

Trophy and Sport Hunting: Page 6

Local villagers in Kankani, India, have turned the tables on hunters of the threatened Blackbuck. This town, located in the Rajasthan desert of western India, has a history of preserving nature, refusing to allow an 18th century maharajah to cut their trees by encircling them and vowing to be killed rather than let the maharajah's men cut the trees (Bearak 1998). When hunters in all-terrain vehicles awoke the villagers with gunshots in October 1998, the villagers chased them off and got the license plate number of the driver (Bearak 1998). Some bucks of these striking black-and-white antelope had already been killed. "These animals are considered sacred to us, and we consider their lives more important than even our own," said a village elder of the Bishnoi people (Bearak 1998). The license turned out to belong to a famous movie actor, Salman Khan, star of many high-action, violent films (Bearak 1998). The story was told in many newspapers, and public opinion turned against Khan, who came to symbolize the callous rich who take pleasure in poaching endangered species like the Bengal Tiger and Sarus Crane (Bearak 1998). The week before, he had hunted Chinkara (*Gazella bennetti*), a Conservation Dependent species, according to the IUCN. On October 12, 1998, the actor was arrested, but he was unlikely to go to jail, as a result of his fame and wealth. The village elder said: "Between us and the animals there is complete trust. Our teachings tell us that we must serve as protectors and nurturers of all living things" (Bearak 1998).

Trophy Hunting Clubs

The US-based Boone and Crockett Club keeps records of trophy animals for North American mammals, and Safari Club International (SCI) maintains international records and promotes trophy hunting of animals worldwide. US state wildlife departments tend to favor sport hunting, and many earn large license fees from the trophy hunting of Bighorn Sheep, Elk, Grizzly Bear, Gray Wolf and other mammals. Trophy hunters in North America vie with one another to receive the "Outstanding Hunting Achievement" trophies awarded each year, primarily for having killed one each of 29 big game animals, some of which are on the US Endangered Species Act list (Williams 1991). Trophy hunting organizations have "master measurers" who check the size of horn, antlers and other measurements of animals killed for record books. SCI gives awards to those who kill at least 13 of the world's 22 species of "available" wild sheep (Williams 1991).

Rifles that fire at distant targets with telescopic lenses, elaborate blinds, heat sensors, and other technological gadgetry have weighted the contest so much in favor of the hunter that animals have become mere targets, with virtually no

hope of escape. Hunters using these high-powered rifles revel in recounting their experiences in hunting publications, whose writing fees help pay for their trips. One hunter's 1997 account recorded his delight in seeing the look of total shock of an Alaskan Dall Sheep (*Ovis dalli*) as it died from a shot he fired without it even having been aware of his presence. The hunter had selected the largest male with the most massive horns, which curved into a complete circle. Such hunting can so terrify animals that they run off cliff edges or flee into places from which they cannot escape.

Bernard Grzimek's *Animal Life Encyclopedia* recounts a hunt in the Canadian Rockies of Mountain Goats (*Oreamnos americanus*), in which five animals were pursued by hunters. They fled in terror, becoming entrapped on the ledge of an overhanging cliff, unable to move in any direction (Grzimek 1968). The hunters returned to their camp where they could see the goats as they stood on the ledge. The next day, the goats were still standing on the spot, but during the following days, they gradually became weakened and fell, one after another, usually at night, to their deaths. The last of the animals fell after 10 days (Grzimek 1968).

One US trophy hunter, Donald G. Cox, has hunted in 68 countries, taken 208 different species, including 125 from Africa, and has killed 23 of the world's spiral-horned antelope (Williams 1991). Trophy hunters try to kill as large a number of species as possible and as many trophy-sized animals as they can shoot. Many trophy hunting organizations claim to have made major contributions to conservation, but documentation is often lacking. SCI has published brochures in which it claims that it purchased habitat for endangered species. As it turned out, on investigation these claims were unsubstantiated (Williams 1991). Endangered animals are often the prime targets of trophy hunters. Safari Club International makes regular applications to the Fish and Wildlife Service to import trophies of endangered species. A 1978 application was particularly stunning because it requested permits to import 1,120 animals of a wide range of species, including Orangutans, various species of monkeys and crocodiles, and 39 species of endangered deer, gazelles, wild sheep, antelope, rhinoceroses, and 12 species of endangered wild cats. After a public outcry, the Safari Club withdrew its application, but in 1982, it was successful in its long battle to allow importation of Leopard trophies.

Trophy hunting clubs have made financial contributions to officials in foreign countries to receive permission to hunt endangered species and have convinced wildlife officials in countries such as Pakistan, Zimbabwe and Botswana that trophy hunting fees pay for conservation and should form the basis of wildlife management programs. The profits from trophy hunting pale beside those of ecotourism, however (see Trophy Hunting vs. Ecotourism Revenues section below).

Illegalities

Trophy hunting organizations have lobbied the US Department of the Interior for decades to weaken law enforcement "overzealousness" and have, on occasion, been successful. The Law Enforcement Division of the US Fish and Wildlife Service has tended to be strict in prosecuting trophy hunters for violations. In one case that inflamed Safari Club International members, it subpoenaed pages of the SCI™s *Record Book*, which listed many endangered species, to determine the details of the killing of various protected animals. To shield its members from prosecution, SCI returned information to their members on trophy animals killed at a time when they could not have been imported legally, and deleted this information in the SCI database to avoid further investigations (Williams 1991).

In another case, however, SCI influence won favors from the Department of the Interior. A highly placed official with the Fish and Wildlife Service, Richard Mitchell of the Office of Scientific Authority, allegedly accepted money from SCI in exchange for facilitating permits to get endangered species trophies into the United States (Williams 1991). Correspondence between Mitchell and SCI members included advice on registering as an institution with CITES on behalf of the trophy museum that the organization maintains in Arizona. Mitchell suggested that he would arrange to register several institutions in China and Pakistan in order to trade endangered species "specimens" with them

(Williams 1991). Another official, Assistant Secretary of the Interior G. Ray Arnett, who later co-founded a lobbying organization for trophy hunters, helped a fellow hunter caught importing an endangered species in the early 1980s by ordering agents to return the trophies to the smuggler, Thornton Snider (Williams 1991). Rick Parsons, who founded the Permit Office within the Fish and Wildlife Service, which gave permits to trophy hunters and others wishing to import endangered species, later became the Washington Counsel to Safari Club International, using his government experience to facilitate the permit process for trophy hunters and also lobbying at CITES Conferences on behalf of trophy hunters.

Ted Williams, in a 1991 article in *Audubon* magazine, tells of an appraiser for the Safari Club, R. Bruce Duncan, who arranged for many members of the club to mislabel the trophy animals they killed in foreign countries in order to import them into the United States without prosecution under the US Endangered Species Act (Williams 1991). One Club member imported a Jaguar (*Panthera onca*) pelt from Venezuela, labeled as a "goat hide" under Duncan's advice, and valued at $60; Duncan had appraised it at $11,000 (Williams 1991). Another SCI trophy hunter, Andrew Samuels, was the winner of the 1990 "Weatherby Award" given by a firearms company to the hunter who kills the greatest number of average, as well as record-sized, game animals throughout the entire world and whose character and sportsmanship are "beyond reproach" (Williams 1991). An undercover Fish and Wildlife Service Law Enforcement investigation revealed that Samuels had confided having illegally killed a Bighorn Sheep and numerous endangered foreign animals and smuggled them into the United States by falsifying shipping documents (Williams 1991). These included Jaguars, endangered wild Markhor goats (*Capra falconeri*), rare African antelope, Jentinck Duikers (*Cephalophus jentinki*), Ocelot (*Leopardus pardalis*), and a wild Asian sheep, the Punjab Urial (*Ovis orientalis punjabiensis*) (Williams 1991). Samuels paid $100,000 in fines, spent 30 days in jail, and performed 800 hours of community service; he also forfeited his world hunting rights for three years (Williams 1991).

In another case, John Funderburg, the curator of the North Carolina Museum of Natural Sciences in Raleigh, acquired more than 1,800 animals as "specimens," many of them endangered, that had been killed by trophy-hunting acquaintances (Williams 1991). They were donated to the museum as tax-exempt, but had little scientific value because they lacked information about the location or date where they were killed, and many were merely heads mounted for hanging on walls. Scientific specimens consist of the skins of entire animals, or their skeletons. A number of the donated trophy animals mysteriously disappeared from the collection, apparently returned to the donors (Williams 1991). In exchange for financial "donations" to the museum, the trophy hunters received the title of "associate curator," with certificates that allowed them to misrepresent themselves to foreign wildlife officials in order to obtain permits to kill protected animals (Williams 1991). Funderburg urged the hunters to send him the trophy animals via private taxidermists to avoid the attention of authorities, but a five-year undercover investigation by Fish and Wildlife Service Law Enforcement revealed all the details of this scam (Williams 1991).

The highly respected Smithsonian Institution has not been invulnerable to such unprincipled arrangements. A wealthy real estate developer, Kenneth Behring, pledged $20 million to the Institution's National Museum of Natural History in 1999, the largest donation in the 151-year history of the museum (Golden 1999). Behring, a trophy hunter and past president of Safari Club International, donated the remains of four endangered Central Asian wild sheep, including the Kara-Tau Argali (*Ovis ammon nigrimontana*) of Kazakhstan, listed as Critical by the *2000 IUCN Red List of Threatened Species*, to the museum. This animal cannot be imported legally because it is listed on the US Endangered Species Act, but on behalf of Behring, the Smithsonian petitioned the Department of the Interior to waive the ban in order to have the trophy shipped into their collection (Golden 1999). This action set an unfortunate precedent for this august institution. Behring is also under investigation for illegally killing three bull elephants in Mozambique, in spite of a $20,000 "donation" he made to a local hospital in the province (Golden 1999). The head of Mozambique's wildlife department, Arlito Cuco, said that the hunt was illegal, "Because according to the law in Mozambique, you cannot hunt for sport" (Golden 1999).

Hunting magazines often glorify the pursuit of endangered species. An article in *Sports Afield* encouraged the hunting in Mexico of Jaguar, Ocelot, and "crested Guan," or Horned Guan (*Oreophasis derbianus*), a highly endangered pheasant-like bird (Anon. 1981). It noted parenthetically, "However, United States laws prohibit bringing in skins"

(Anon. 1981).

Effects of Trophy Hunting on Animals

Among the most coveted of the "Grand Slam," or the most prestigious trophy animals, is the Brown Bear. The Kodiak Bear (*Ursus arctos middendorffi*) of Alaska represents a major trophy for hunters who come from all around the world to kill large males. This bear exceeds other subspecies in size, weight and skull size. These bears have been isolated since the end of the last Ice Age, and the abundant food supply of salmon runs, berry bushes and other edible plants in their habitat has produced this giant bear (Chadwick 1990). Trophy hunters pay $20,000 or more to private hunting guides for the privilege of shooting these bears. A recent study has revealed a potentially disastrous effect on the species of this trophy hunting. According to *The Kingdom. Wildlife in North America*, by the respected author and National Geographic Society correspondent Douglas Chadwick, "Continued harvesting of the biggest animals by trophy hunters has caused a decline in the average size of Kodiak Bears over the years" (Chadwick 1990). Thus, this record-size animal is gradually becoming smaller and smaller as a result of trophy hunting.

The pressure of hunters on some populations of Alaskan bears is so intense that it has altered the behavior of males, preventing their normal feeding on salmon runs. On Admiralty Island in southeastern Alaska, part of the Tongass National Forest, tourists watch female Brown Bears fishing with their cubs, but rarely see males because they have become so wary of people after years of being hunted; even females without cubs can be hunted on Admiralty Island (Crittenden 1997). The rich salmon rivers on this island are among the world's most productive, and since clearcutting of timber has been banned, salmon thrive in the clear water. Salmon is an important portion of the diet of male bears, yielding a great deal of protein and helping to fatten them for the winter. By frightening the male bears from the salmon rivers, which they have fished for thousands of years, humans may be affecting the health, survivability and size of these bears. Each year more than 40 Brown Bears are killed on Admiralty, and hunters are lobbying to reopen hunting in areas such as Pack Creek that are now closed to protect the fishing spots (Hanson 1998). This island deserves to be declared a National Park, which would protect these bears from hunting.

Another effect of hunting male bears has recently been documented by Swedish and Norwegian biologists, who found that in areas where resident adult male Brown Bears had been killed to thin the population, bear cubs suffered very high mortality for several years until dominant males reoccupied the territory (O'Neil 1997). Male bears, who have traditionally been considered threats to cubs, may be a danger only to cubs they have not fathered. Thus, the killing of bears by sport and trophy hunters may also result in the deaths of hundreds of bear cubs.

Russian Brown Bears have been hunted heavily in recent years. When a prominent government official, Prime Minister Viktor S. Chernomyrdin, announced early in 1997 that he wanted to trophy hunt a Brown Bear, local guides bulldozed a path to the den of a sleeping female bear (Filipov 1997). Tractors plowed a campsite for a large tent with mobile kitchen and cafeteria, and the Prime Minister flew in by helicopter (Filipov 1997). Chernomyrdin, accompanied by 12 hunters, rode a skimobile to the site, roused the bear and killed her two cubs and the mother. This incident received much adverse publicity in Russia. When the Prime Minister was criticized for his lack of sportsmanship, he replied: "What's wrong with that? Hunting of bears is not banned; it's a normal thing . . . I'd like to watch those who are writing about this meet those bears eye to eye to see their reaction" (Filipov 1997).

In Greece and Turkey, where Brown Bears are avidly hunted in spite of their dwindling numbers, cubs orphaned when their mothers are killed are often sold to zoos or to gypsies who treat them abusively. This trade is illegal in both countries, and the World Society for the Protection of Animals (WSPA) has saved many of these gypsy bears, who are dragged through the streets with nose rings and made to perform tricks. WSPA has placed several hundred of these abused bears in large wooded compounds, unfettered for the first time in their lives. Some had to be euthanized because of severe infections that had caused them extreme pain and serious physical disabilities that they had endured

for many years without veterinary treatment. The majority suffered the effects of malnutrition.

The animals trophy hunters seek--the finest specimens--are the very ones that should be left in the wild to maintain the species. Killing the largest specimens of a species, subspecies or population is likely to diminish it in size and survivability. This would seem elementary, but trophy hunters, state game departments, many in the Fish and Wildlife Service, the World Wildlife Fund and other organizations in favor of trophy hunting do not discuss or acknowledge this fact. Claims are made on behalf of trophy hunters that only old and non-breeding adults are killed, but this contention has been proven wrong in case after case. Brown and Grizzly Bears continue to breed until an advanced age. Other trophy animals have also been shown to be at their prime when shot.

Lions are a prime target of trophy hunters, who select the largest male specimens, especially those with enormous manes. Two filmmakers, Derek and Beverly Joubert, in producing their dramatic series, fiLions of Darknessfl for the National Geographic Society, followed three exceptionally large males for a long period. These magnificent Lions spent most of their lives in a national park in Botswana, but made the fatal mistake of leaving the park and entering a wildlife management area where trophy hunting was allowed. All were shot within a short time at the prime of their lives by trophy hunters.

Trophy hunting took a tragic and highly controversial turn when the government of Tanzania sold trophy hunting rights for African Elephants at more than $4,000 per animal in the early 1990s. The *2000 IUCN Red List of Threatened Species* classifies this species as Endangered. The government claimed that the largest animals, which for trophy hunters were the most desirable, were not active breeding males, but past the breeding age and, therefore, "excess." Tanzania issued 50 permits a year for trophy-hunted elephants (Brody 1994). At least four very tame bull elephants that had been studied for decades in Amboseli National Park in southern Kenya by biologist Cynthia Moss, author of two classic books, *Echo of the Elephants* and *Elephant Memories*, wandered into Tanzania in 1994, where they were shot at point-blank range by trophy hunters (Moss 1995). The hunters had received CITES permits from the Tanzanian government to export the tusks as hunting trophies (Moss 1995). Northern Hunting Enterprises, which organized the Tanzanian elephant hunt, is run by Rick Trappe, a German Tanzanian; the hunters were two Germans and an American (Brody 1994). One of the bulls killed, called "R.B.G.," was 47 years old at the time of his death, based on aging of the jaw--not old in elephant years--and so habituated to vehicles that he could be easily approached to within a few feet (Moss 1995). Cynthia Moss said she was "devastated" by the loss of the animals, who had come to trust researchers, tourists and rangers. She stated: "The message they got from us was, 'It's OK, we're not going to hurt you, you can trust us.' Then one day they walk two kilometers into Tanzania, where they'd been going for most of their lives, and they're blown away . . . I feel as if was lying to them" (Brody 1994). A spokesperson for the African Wildlife Foundation said: "The ethics of shooting these virtually tame animals is appalling. You can't call this a hunt of any kind" (Brody 1994). Had R.B.G. not been shot, he would have lived another 18 years, according to Moss (Brody 1994).

These were among a relatively small number of large, old bull elephants left in East Africa, protected through the ivory slaughters of the 1980s by the presence of field researchers and tourists. The assertion that they were non-breeding males was refuted by Moss, who had documented that they were active breeders and, in fact, among the top breeding bulls in the Amboseli population (Brody 1994). This disputes the view that they were not contributing to the gene pool and were "excess," worthy only of being used as targets. After protests and adverse publicity on television programs that reached the United States and elsewhere, Tanzania announced a ban on trophy hunting of elephants near the Tanzania/Kenya border on December 13, 1994, and initiated an investigation into the granting of permits to shoot the Amboseli bull elephants.

In spite of the supposed ban, two other big bulls of the Amboseli, Sleepy and Beach Ball, both in their 50s, were killed in Tanzania by trophy hunters in 1996. Both had fathered calves that were born after their deaths. The largest bull in Cynthia Moss's study area is the gigantic Dionysus who, at 55 years old, weighs some 6,000 kilograms, with 100-pound tusks. He probably owes his life to Cynthia Moss and other researchers who have deterred poachers, but should he wander into Tanzania, he may be killed. The females in the family, headed by Echo, an old matriarch, prefer

Dionysus above all the males, and he has fathered many calves. In a BBC film about her work in Africa, fiEcho of the Elephants. The Next Generationfl (PBS--WNET 1996), Moss pledged that she would spend the rest of her life watching over these elephants.

Another effect of trophy hunting of elephants and many other animals is an imbalance that is created between the sexes. The largest elephant bulls of both the African and Asian species have been killed off, leaving far too few males for the number of adult females. In some parts of Africa where the ivory massacres were the most intense during the 1970s and 1980s, virtually no adult males remained prior to the 1989 CITES ban on ivory. In Asia, adult male Asian Elephants (*Elephas maximus*), also listed as an Endangered species by IUCN, have become extremely rare because they were killed by ivory poachers. Females do not have tusks, and most have been spared by ivory hunters. In parts of Asia, males without tusks, a recessive trait, have come to dominate some populations, since they are not valuable for their ivory. This is altering the traits of the species.

After the largest bull African Elephants were killed off, trophy and ivory hunters turned to the older females, who have large tusks. They are essential in maintaining and leading family groups, providing experience, protection and guidance (Moss 1995). These older females, or matriarchs, have accumulated survival lore over many decades, acquired from previous matriarchs and their long life experiences. They also know the location of scarce water holes in the dry season, where to find minerals in clay they need for their nutrition, what plants are poisonous and other bits of survival lore that can mean the difference between life and death of herd members. Yet these matriarchs also were killed in the 1980s, leaving young, traumatized teen-aged females, who wandered in disarray, without the knowledge or authority of the older females. Females as young as 10 years old found themselves matriarchs of bands of orphan calves, many just weaned. Without direction, they often blundered, placing the calves at risk.

Scientists studying elephants over the past 30 years have documented hundreds of cases of trauma and apparent mourning when family members were killed. The elephants that suffer the most are the young who see their mothers and relatives butchered in front of them. Researchers in the 1990s have noted that many of these young elephants fail to develop normally and are extremely shy, unable to find food and cope with predators as effectively as adults. Some young males, who were calves when they watched as their families were slaughtered by poachers or in culls in South Africa, were released in national parks where they later became unruly and destructive to property and to other animals. Only when older elephants were released to lead and discipline them did they calm down and assume the peaceful personality that characterizes the species.

Zimbabwe, Botswana and Namibia submitted proposals in 1997 to the CITES Conference that the African Elephant's population in their countries be down listed from CITES Appendix I to Appendix II to allow export of trophy-killed elephants. Zimbabwe requested commercial trade in trophies, and Namibia, non-commercial trade. This proposal was amended to read "for non-commercial purposes" and adopted by the CITES members at the 1997 Conference. This is a step in the wrong direction, as hunters will arrive in these countries from around the world to kill the largest, prime elephants as trophies. Shooting elephants in open country where they have no cover is hardly sport, yet the hunting companies tout their massacre as a feat of bravery. Killing them as they come to drink at the few water holes that remain in the dry season in southern Africa is also unsportsmanlike. Matupula Hunters of Texas calls such hunting "exciting and rewarding." Their brochure states, "With the country dry and surface water limited, the elephant bulls can be tracked going to and from water, or in amongst the woodlands and forest where they feed and lay up" (Scully 1997).

Trophy Hunting vs. Ecotourism Revenues

The irony of the slaughter of elephants and other large mammals for trophies is that the funds accrued from trophy hunting or ivory are miniscule in comparison to the value of these animals as ecotourist drawing cards. In Kenya, a

1989 analysis on the viewing value of elephants found that between $25 and $30 million per year was earned in tourist dollars from people attracted to the elephants alone (Brody 1994). A new project provides a local Maasai tribe with about $23,000 a year from tour operators who camp there primarily to show visitors the big bull elephants that are now so rare in East Africa (Brody 1994). During the long life of an African Elephant, it may produce tourist revenue worth $1 million, distributed to a wide range of recipients, from airlines to travel companies, and to local economies (Currey and Moore 1994). By contrast, a trophy-hunted elephant brings a one-time fee of $4,000 to $20,000. Estimates for African Lions are similar. A fully maned male Lion, according to Lee Durrell (1986) in *State of the Ark*, is worth $500,000 as a tourist attraction, whereas a Lion shot for sport or trophy is worth between $3,500 and $8,500, and its skin about $1,000.

Ecotourism has shown an astronomic rise within the past decade, with magazines, books and films aimed at the ecotourist and soaring revenues accruing to countries that protect their natural heritage. Most tourists prefer to come to a country where the animals are tame and where senseless killing is not carried out. Countries that allow hunting of the largest specimens of their wildlife, whether elephants or Leopards, are likely to suffer loss of tourist revenue because they have fewer larger animals and the hunted species often become either shy, hiding from tourists, or belligerent, charging them. A recent article in *Africa. Environment and Wildlife*, a magazine affiliated with World Wildlife Fund South Africa, gave advice to tourists coming to Okavango. Daryl and Sharna Balfour (1998) recommended that tourists avoid coming during hunting season, which runs from early April to mid-September, because game is "scarce in this areas, skittish and almost impossible to approach." They further noted that the sound of gunfire and the sight of carcass-laden vehicles can be disconcerting (Balfour and Balfour 1998). Wildlife can remain shy throughout the year, especially sensitive, gun-shy animals like elephants, and even beyond the suffering caused to the animals, this trophy hunting potentially deprives the country of far greater revenues that tourists could contribute. Several tourists have been killed recently by charging African Elephants in areas where the animals had been trophy hunted.

Tourists coming to South Africa have increased in number in recent years, producing revenues totaling $6 billion in 1995; a large percentage of this total derives from tourists coming to see scenery and wildlife. By contrast only $2 million in trophy hunting fees for rhinos, and a few million dollars more for other animals, were earned in that year, according to the Natal Parks Board (Hughes and Brooks 1996).

Botswana earns $100 million per year from tourism and only a tiny fraction from trophy hunting, yet the government actively promotes the latter activity and has failed to give national park status to its crowning jewel, the Okavango Delta. Portions of this superb wildlife area have been designated as game reserves which allow hunting, but most remains unprotected (Balfour and Balfour 1998). By contrast, Kenya has designated vast areas as national parks and has encouraged ecotourism for decades, with the result that the government earned $500 million in 1996, up from $452 million in 1995. A new organization, Okavango Peoples' Wildlife Trust, in Botswana, is pressing for a complete ban on trophy hunting in the immense Okavango Delta wetland (Jackman 1997). As a result of livestock fencing in the area, African Buffalo are declining 18 percent a year, and Lion, zebra, Sable Antelope and waterbucks are also becoming scarce (Jackman 1997). This organization has proposed that all hunting, except for subsistence or problem animals, be banned and that the Delta be promoted as an ecotourism center, with low-impact camps for luxury visitors (Jackman 1997). New fencing has blocked about one-fourth of the Okavango to wildlife, who migrate to this oasis from surrounding desert areas as a vital refuge for many months during the year. These fences also have blocked wildlife migrations between Namibia and Angola, a disastrous event for many thousands of animals (Jackman 1997). This region has enormous potential for ecotourism that would far outweigh the revenues from cattle ranching or trophy hunting.

In general, funds from trophy hunting end up in government coffers and in the pockets of a few tour operators; the people of a country receive little of the revenues. By contrast, ecotourism funds are spread throughout the local economies, with hotels, taxis, buses, restaurants, souvenir shops and others benefiting from the greater number of tourists than hunters. In fact, the number of trophy hunters is miniscule in comparison to the number of ecotourists. In most countries, hunters amount to a few hundred or thousand, versus hundreds of thousands--or even millions--of

tourists. In some countries, a portion of trophy fees and the meat from slaughtered animals are shared with local villagers, but if they were given the same share of tourist money, it could be very profitable. This trend of sharing tourist revenues or park fees with local people is making an enormous difference in the lives of people around the world.

Meat Hunting

Three Asian wild cattle are endangered from hunting, and one of these is on the verge of extinction. The Kouprey (*Bos sauveli*), discovered in 1937, is classified as Critical by the *2000 IUCN Red List of Threatened Species*. Native to open lowland forests of Southeast Asia in Cambodia, Laos, Thailand and Vietnam, it is the size of a steer. Adult males weigh up to 1,980 pounds and stand 6 feet tall at the shoulder (Nowak 1999). Originally, the Kouprey's habitat consisted of low, rolling hills interrupted by patches of forest; it grazed in herds of up to 20 animals, covering some 15 kilometers a day in the open areas and entering the forest for shelter from the sun and refuge from predators (Nowak 1999).

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Meat Hunting: Page 1

Today, much of the Kouprey's habitat has become a battleground for bands of guerrillas who have planted land mines throughout the region and hunt and snare wildlife for food. After the Vietnam War and the Khmer Rouge occupation of Cambodia, Kouprey were only seen rarely (Stewart-Cox 1995). A 1986 survey found fragmented, small populations remaining in most of its range (Nowak 1999). A few Kouprey were seen in the 1980s trying to migrate through the steep escarpment separating Cambodia and northeast Thailand, but they apparently died in booby-traps set for people (McNeely and Sochaczewski 1988). The skull and horns of a female Kouprey were offered for sale in a shop in Poipet, Cambodia, in 1994 for $400, according to biologists surveying illegal trade in the country (Martin and Phipps 1996). The Kouprey has little chance of surviving without protection from hunting unless a large sanctuary is set aside for it. No strong conservation measures have been taken to date. No Koupreys are in zoos. It is possible that this species is already extinct.

The Banteng (*Bos javanicus*) is similar in size to the Kouprey, with upturned horns and an extremely stocky build. Brown to bluish-black, Bantengs have white legs and a white rump patch. Their range is larger than that of the Kouprey, extending from India to Myanmar (Burma), Thailand and Indochina, south through the Malay Peninsula to Java and Borneo. These animals are being crowded out of their forest and shrubland habitat by settlements and logging, and they are extremely vulnerable to hunting. They have become wary and shy, and large herds are now rare. Banteng have been domesticated in Indonesia and bred with domestic cattle, producing fertile offspring (Nowak 1999). Wild, genetically pure Bantengs are extinct in Bangladesh, Brunei, and probably India as well, according to the *1996 IUCN Red List of Threatened Animals*. The 2000 version of this list also classifies the species as Endangered.

The Gaur (*Bos gaurus*), largest of the three Asian wild cattle, is the most numerous, yet it is listed as Vulnerable by the *2000 IUCN Red List of Threatened Species*. Ranging from Nepal and India to the Malay Peninsula, these massive animals weigh up to 1,000 kilograms (2,200 pounds) (Nowak 1999). They have become extremely rare to absent in all

but protected national parks, and their populations have been estimated as extremely low, only about 1,000 animals (Nowak 1999). These animals are killed whenever possible for their meat throughout their range.

The Annamite Mountains extend along the border between Laos and Vietnam, rising to more than 6,000 feet in some areas, where stands of wet evergreen broadleaf forest harbor some of the strangest and rarest mammals on earth. Not until the 1990s were these remote forests explored by scientists, who examined skins and horns of rare animals killed by Hmong tribespeople. First to come to light in 1992 was the extraordinary Sao la or Vu Quang Ox (*Pseudoryx nghetinhensis*), a beautiful, gray, goat-like antelope. Its genus, *Pseudoryx*, meaning false oryx, indicates its superficial resemblance to oryx because of its long, straight, backward pointing horns. Weighing up to 200 pounds and 35 inches tall, this relatively large animal somehow had escaped the attention of scientists. (See photo in Nowak 1999.) Soon after discovery of several pairs of its horns, rewards were offered for live specimens. Two young calves were captured in Vietnam and placed in the Hanoi Zoo; within weeks, both were dead (Rabinowitz and Schaller 1994). Others were captured by villagers hoping to receive rewards, and some of the animals died (Nowak 1999).

The Hmong people know the Sao la well and hunt them whenever they can. They believe these antelope number at most a few hundred animals (Rabinowitz 1997). Many have been killed since their discovery, and hunters indicate that it has disappeared from some areas (Nowak 1999). Only a few hundred Sao las are thought to exist in Vietnam and Laos, where heavy hunting presents a major threat to them in spite of official protection by the Vietnamese and Laotian governments (Nowak 1999). Wildlife Conservation Society biologist Alan Rabinowitz (1997) estimates that they are restricted to an 800-square-mile portion of the rugged mountain forests along the border. In 1994, soon after this animal was given its scientific name, it was listed on Appendix I of CITES to prevent international commercial trade. The *2000 IUCN Red List of Threatened Species* lists it as Endangered. Vietnam set aside the Vu Quang Nature Reserve for these very rare animals and prohibited snaring in the reserve (Rabinowitz and Schaller 1994).

Other rare and newly discovered or rediscovered animals of the Annamite Mountains include two species of muntjac, or barking deer, one of which is the largest of all muntjac species; a long-snouted, yellowish wild hog rediscovered from a skull fragment; a striped rabbit, based on fur pelts found in a local village, which may be the same species or related to the endangered Sumatra Short-eared Rabbit (*Nesolagus netscheri*); and a very endangered palm civet (Rabinowitz 1997). The muntjacs and palm civet were discovered as captive animals, but nothing is known of the others, and searches for the wild hog have been unsuccessful (Rabinowitz 1997). Had these intriguing and unusual animals been discovered in a wilderness area in North America, they would be the subjects of field surveys and strict protection, as well as extensive media coverage. In Asia, where diversity is far greater and conservation a luxury few can afford, even such fascinating species may fade into extinction for lack of funding for conservation programs.

Throughout the region, much of the larger wildlife, from deer to large predators, has been hunted out, and guerrilla warfare has left the land marked with bomb craters and land mines. Alan Rabinowitz (1997), who has lived in Southeast Asia and witnessed overhunting in many countries, says, "The killing of wildlife in Laos was unlike anything I had seen elsewhere." Even within the Nakai Nam Theun Reserve, "walls of death" were constructed of thatch, bamboo and small trees, with openings rigged with snares; animals walking along the wall would be caught when trying to pass through an opening, snared by a leg or the neck, to "die a slow death" (Rabinowitz 1997).

Meat Hunting: Page 2

A wildlife slaughter of enormous proportions is taking place in Central and West African countries. Rural people who once killed animals only for personal consumption now hunt professionally, and markets in villages and cities now sell thousands of monkeys, antelope, wild cats, pangolins and even endangered apes (Pearce 1995, McRae 1997). Hunters use wire snares and leghold traps, high-powered rifles and dogs to track down animals. The tropical rainforests of west-central Africa, which once teemed with wildlife and echoed with their calls, are now falling silent.

For miles surrounding villages, wildlife has largely disappeared as local peoples throughout this vast region are killing every animal to sell its meat and body parts. Professional hunters have taken so much wildlife that little is left for local tribes. Logging corporations based in Europe have launched this commercialization of bushmeat by opening up previously impenetrable wilderness areas with logging roads and offering to buy animals that local people kill. Both the forests and the wildlife are being devastated.

Logging companies have taken advantage of these impoverished countries' national debts, buying rights to clearcut the majority of the remaining primary tropical rainforest in West and central-west Africa at bargain prices. The last primary forests in Cameroon, the Congo, the Democratic Republic of Congo and the Central African Republic are being cut and bulldozed, and their wildlife exterminated. Five-hundred-year-old trees with massive trunks 20 feet around, standing more than 100 feet tall, fall daily. The old-growth forests that provide homes for a myriad of wildlife will soon be gone at the present rate of cutting. In some areas, the logging is selective for certain species of trees, but this reduces forest diversity, and hundreds of trees are destroyed in the process of obtaining a few. When great trees fall, they bring down others, and logging roads and entry roads into forest tracts take thousands more trees.

In a shocking and moving report, *Slaughter of the Apes. How the Tropical Timber Industry is Devouring Africa's Great Apes* (Pearce 1995), the World Society for the Protection of Animals documents the tragic and gruesome slaughter of hundreds of Gorillas, Chimpanzees and other wild animals in Central African countries in this trade. The commercialization of wildlife and environmental devastation that have resulted are activities totally antithetical to the legislation and conservation ethics of the European countries--France, Germany, Italy, the Netherlands, Belgium and Denmark--that are sponsoring the logging (Pearce 1995). Several documentary films shown on the National Geographic Explorer program and CNN have shown the markets with thousands of small antelope, Chimpanzees, Gorillas, monkeys and other mammals lying dead on tables, offered for sale. fiAfrica Extremefl and fiNdoki Adventurefl are National Geographic films shown in March 2001 that document the discovery of poachers' camps with dead forest antelope, Leopard skins and other wildlife. One incident of snaring was filmed. A hunter filmed in the remote Ndoki Forest of the former Zaire found a Forest Pig struggling in a wire snare. The hunter began hitting the pig in the head to cause death, while the animal screamed and kicked. Only after hitting the animal about six times did death finally occur. Local hunters interviewed by the photographers said they regularly killed Bongos (*Boocercus euryceros*), rare and extremely beautiful rainforest antelope that are closely related to giraffes. These films traced the 1,500-mile voyage by Wildlife Conservation Society biologist Michael Fay through the last rainforests of the Democratic Republic of Congo and Gabon to publicize the fact that these magnificent wildernesses are being logged and their wildlife killed, and urgent action is needed to stop these activities.

Hundreds of Lowland Gorillas are being killed for the meat trade and sold for $40 per animal. Loggers place orders for Gorilla meat, which encourages the snaring and shooting of virtually every Gorilla that local people are able to procure for this grisly trade. WSPA found that in one district of the Cameroon, 800 Gorillas a year were being killed (Pearce 1995). Swiss photographer Karl Ammann has spent years fighting this trade (McRae 1997), and in the late 1990s, conservationists from around the world began efforts to save these beleaguered apes from slaughter.

In the forests of southeastern Cameroon, Ammann and Michael McRae, a journalist, found an infant Gorilla being kept in a dark mud-hut; the tiny animal was cowering in the corner, grinding its teeth and straining against its tether. The owner explained that the Gorilla™s parents had been shot two weeks earlier by a village hunter, the male having been wounded as he charged to defend the family, but escaping. The mother Gorilla died clutching her baby; she was then gutted and carried out of the bush, cooked and eaten (McRae 1997). Malnourished baby Gorillas are kept to be sold to passing trucks, but usually die within days. Ammann, after years of witnessing these tragedies, concluded, "Chimpanzees have the will to live if they're separated from their family, but Gorillas fall into a depressive state, and just give up on life" (McRae 1997). One baby Gorilla photographed by WSPA had been stuffed into a suitcase, where the Gorilla died of starvation after days of suffering (Pearce 1995). Another baby Gorilla was filmed lying dead in a battered cardboard box. CNN reporter Gary Streiker filmed an orphan baby Gorilla, tied on a string leash, being kicked and taunted. Huge cargo boats chug along the Congo River and other waterways of the Central African rainforest that serve as highways, carrying hundreds of orphan Chimpanzees and Gorillas to markets, stuffed in boxes

and bound with rope. fiDown the Dark River,fl a 1996 film by CNN, captured the squalid and cruel conditions that baby Chimpanzees endured on these boats. When sold as pets, baby Chimpanzees are often placed in outdoor dirt yards, lonely, solitary little gnome-like figures with sad eyes, hugging themselves or clinging to dirty cotton cloths. When they grow older and become strong and difficult to manage, they are usually killed and eaten (McRae 1997).

The total Lowland Gorilla population is not known with any certainty, and "guesstimates" of 100,000 put forth in 1985 are probably greatly exaggerated. Their true numbers are probably half that, and in steep decline (McRae 1997). Several bushmeat hunters were interviewed in fiThe Bush Meat Trade,fl a film shown on the National Geographic Explorer television series in 1995. When asked why they shoot these magnificent and protected animals, the hunters defended themselves by saying: "What's wrong with killing a Gorilla? They're fierce." One of the hunters told McRae that he was sure Gorillas were plentiful: "In Cameroon there are a million Gorillas. Three weeks ago, I saw sixty in one day. I shot three and then stopped . . . Why should I feel bad for a Gorilla? He is just a stupid animal" (McRae 1997). The West African country of Gabon also has markets where huge amounts of bushmeat are offered for sale, including Chimpanzee heads and Gorilla parts (Walters 1996).

Monkeys are killed on sight by the hundreds by hunters for sale in meat markets. Traders on the boat trip filmed in fiDown the Dark Riverfl were transporting some 30 or more dead monkeys, strung together with cord wrapped around their necks. These colorful and delicate rainforest primates are rapidly disappearing throughout their range. Monkeys from the forests surrounding the Congo River are bought by traders from hunters along the boat routes, or by logging truck drivers, and sold for $1 each in cities such as Kinshasa to be smoked for human consumption. Some traders traveling on riverboats specialize in bushmeat and barter with local people for monkeys, apes, turtles and other animals, some kept alive for the journey to preserve freshness of the meat, and others dead, stacked in piles.

WSPA has launched a campaign called EscAPE to encourage African governments to enforce existing hunting laws and police the trade in ape meat and body parts. WSPA personnel have rescued baby Chimpanzees and Gorillas from being sold as pets or abandoned, placing them in zoos or sanctuaries. A conference organized by WSPA invited loggers, conservationists, government representatives and organization representatives to discuss the bushmeat market and possible ways of ending it. The loggers boycotted the meeting, but others attended and, after two days, drafted a long list of resolutions, including enforcing existing laws, instilling conservation ethics, and restricting the logging trade (McRae 1997). In December 1995, Ammann and WSPA presented information on the trade to a committee of the European Parliament, distributing their report (Pearce 1995), and at a subsequent meeting of Afro-Caribbean-Pacific nations and the European Union, 140 delegates passed a resolution urging action (McRae 1997).

The bushmeat trade has become the foremost threat to wildlife in Central and West Africa's forests, an even greater threat than logging (McRae 1997). Urgent action to substitute other sources of income is needed. Ecotourism has been suggested, as well as employing hunters to conduct wildlife counts and become rangers. To date, no coherent program has been set into place, and hunters claim that they will continue to kill large numbers of animals until they find an adequate substitute.

Bonobos (*Pan paniscus*), or Pygmy Chimpanzees, number only about 13,000 in a restricted area of the former Zaire's dwindling rainforests. As the most endangered of the apes, exploitation could cause their extinction. WSPA documented illegal trade in these primates (Pearce 1995).

A study of the bushmeat trade in western Cameroon found serious declines in several other species of primates, caused by the meat trade. The rare Preuss's Guenon (*Cercopithecus preussi*) and the highly endangered Drill (*Mandrillus leucophaeus*), a large monkey listed on the US Endangered Species Act and Appendix I of CITES, are also being hunted for market sale. In one hunt alone, 30 Drills were killed (King 1994). Troops in the area have declined in number. One monkey, the Russet-eared Guenon (*Cercopithecus erythrotis camerunensis*) has been hunted to extinction there, and all primates from the Mount Manenguba region have declined dramatically (King 1994). In Sierra Leone, 300 tons of monkey meat are exported to Liberia each month, decimating wild populations of Red

Colobus (*Procolobus badius*) and Diana Monkeys (*Cercopithecus diana*). All these primates are listed by the *2000 IUCN Red List of Threatened Species* as Endangered. Scientists predict extinction in the region for the Red Colobus in 10 years, and the Black and White Colobus (*Colobus guereza*) in 20 years. Gabonese markets also offer various species of monkeys for sale. In one market, three small monkey heads were lined up on a gutter curb. Two of the faces were expressionless, and the third was open-mouthed, its eyes staring under furrowed brows, "as if frozen in a final, terrified gaze" (Walters 1996).

The Gabonese bushmeat trade, while not linked to commercial logging, has nevertheless grown in size and, in 1993, accounted for almost 11 percent of the country's gross domestic product (Walters 1996). A 1993 study found that, in a single city, more than 5,000 animals of 43 species of mammals, reptiles and birds were sold per year. Guenons; the magnificent and colorful Mandrill (*Mandrillus sphinx*), a Vulnerable species; Black Colobus; Chimpanzees; Gorillas; four species of duiker antelope; pangolins; Brush-tailed Porcupines; mongooses; genets; civets; and African Golden Cats are among the mammals killed for sale in Gabonese markets (Walters 1996). Birds being sold in these markets include crowned eagles, vultures, hornbills, guineafowl and plaintain eaters (a type of turaco). Pythons, Gabon Vipers, Nile Monitors, hinge-back tortoises and even threatened West African Dwarf Crocodiles (*Osteolaemus tetraspis*) were being marketed. Even animals protected under Gabonese law as endangered species are offered openly for sale. In addition to Gorillas and Chimpanzees, the Giant Pangolin (*Manis gigantea*), a race of the Potto (*Perodicticus potto*), and Demidoff's Dwarf Galago (*Galagoides demidoff*), nocturnal primates, all threatened species, could be obtained clandestinely (Walters 1996). In some areas of Gabon, high-ranking government--as well as local--officials supply hunters in villages with rifles and ammunition. Hunters then decimate wildlife and exchange the dead animals with traders for beer or soap. The traders then sell them for large amounts in city markets (Walters 1996). Hunting takes place throughout the forests, which still cover much of the country, and even in protected reserves where hunting is not allowed (Walters 1996).

An environmental organization, ECOFAC, has set up an ecotourism project to attract visitors to one of Gabon's wildlife havens, the Lope Reserve. Paths have been made through the forests, and 24 elevated observation posts have been built by members of the Scottish Primate Research Group, who have spent years habituating mangabeys and Chimpanzees to human contact (Walters 1996). The goal is to provide local communities with an alternate form of income from tourism and, perhaps, to spread the concept throughout the country and elsewhere in tropical forests where viewing wildlife is not as easy as in open savannah habitats.

The wild animal trade of Central and West Africa is obliterating populations of small forest antelope, such as various species of duiker. Twelve species of central and west African duiker are listed in the *2000 IUCN Red List of Threatened Species*. The meat trade and unregulated hunting, accompanied by destruction of forests, are the major threats. These animals are killed by capture in snares, where they may struggle for days. Two small, delicate antelope, both on CITES Appendix II, the Blue Duiker (*Cephalophus monticola*) and Bay Duiker (*Cephalophus dorsalis*), are trapped in wire snares or taken in pit traps in the Cameroon (King 1994). Dismembered duikers were seen in a market in Libreville, the capital of Gabon, in 1995 (Walters 1996).

Illegal snaring for antelope meat in national parks has been a major threat to Mountain Gorillas (*Gorilla (gorilla) beringei*), who number only about 650 animals. Many have lost their hands to snares, but some have now learned to recognize these traps and spring them. In 1995, however, a baby Mountain Gorilla strayed from the group and became snared, crying and struggling in terror for almost 24 hours while family members watched helplessly until Virunga National Park guards cut him free. Others have died in these snares.

Congo's national park, Odzala National Park, an area of 1,000 square miles, until recently had the region's only unexploited populations of African Elephants, African Buffalo and other mammals. Because of a lack of guards, poachers are now invading the park. The European Economic Community has agreed to fund the hiring and training of guards, with help from the Congolese army. This country is nearly bankrupt, like neighboring countries, making wildlife protection extremely difficult. Private hunting safaris enter the Congo rainforest and, for a fee, a foreign hunter can kill rare species of antelope and other wildlife.

Those who eat African monkeys and apes may be risking death. Several people who ate a dead Chimpanzee they found in the forest in Gabon died of the dreaded ebola virus, and the disease threat is not well-known to those who eat the meat of primates. Sooty Mangabeys harbor a virus related to HIV-2, an AIDS-like virus, and McRae (1997) saw a hunter carrying dead mangabeys, dripping blood into scratches on his leg.

In the Amazon, primates are avidly hunted for meat. Russell Mittermeier, head of the IUCN Primate Specialist Group, states that thousands of primates are killed by hunters, causing local extinctions of woolly monkeys (*Lagothrix* spp.) and spider monkeys (*Ateles* spp.) in Peru and Brazil. Forest tribes in Suriname kill very large numbers of primates for food, selling the meat in many local markets. The Wildlife Conservation Society (WCS) has been working with several native tribes in South America, evaluating the effect of their hunting on wildlife. They have found that in many cases, natives were overhunting many animals, causing local extinctions, even when only killing for subsistence. Peccaries of various species have been extremely vulnerable.

Meat Hunting: Page 3

Fruit bats of Asia and Pacific islands are killed in large numbers for food, sold by the tens of thousands to markets in Southeast Asia. Two species of the western Pacific, the Little Mariana Fruit Bat (*Pteropus tokudae*) of Guam and the Mariana Fruit Bat (*Pteropus mariannus mariannus*) of Guam, Rota, Tinian, Saipan and Agiguan have both been exploited so heavily that they are nearly extinct. Both bats are listed on the US Endangered Species Act as Endangered, yet the trade continues. On Sulawesi Island in Indonesia, thousands of bats are caught by young boys using kites to entangle them as they fly overhead. These bats are vital as pollinators of many species of commercially important fruit.

Bushmeat hunters in Indonesia and Malaysia are wiping out the populations of many animals. On the island of Borneo, a study conducted by the Wildlife Conservation Society found that hunting, legal and illegal, was the single greatest threat to wildlife (Bennett 1994). In Sarawak and Sabah, two northern states on Borneo, Elizabeth Bennett and her assistants conducted a three-year study of native hunting. These rural people, who previously had hunted only for subsistence, now hunt to sell the meat to town markets (Bennett 1994). Areas that had been inaccessible were opened up by logging roads, and hunters now swarm in the forests, killing any animal they see (Bennett 1994). Except in the most remote areas, all local people now possess shotguns. Squirrels, which have a great diversity of species on Borneo, nearly disappeared in some areas, along with leaf monkeys (Bennett 1994). Bearded Pigs, macaques, deer and porcupines are hunted, speared and trapped by some tribes (Bennett 1994). The only taboo involves the killing of Orangutans, who are protected by legend. Hunting pressures were so great that Bennett predicted extinctions for many animals, and the effects on the forest ecology were equally dire, as seed dispersers are killed off (Bennett 1994). WCS is working with local peoples to educate them about the effects of their hunting, with the cooperation of the Forest Department of Sarawak and the Wildlife Department of Sabah (Bennett 1994).

On the neighboring island of Sulawesi, formerly known as Celebes, WCS conducted a similar study in the Tangkoko-DuaSudara Nature Reserve. The study found that in the past 15 years, populations of the endemic Bear Cuscuses (*Ailurops ursinus*), bear-like marsupials who hang by their prehensile tails from branches, had declined by 95 percent from hunting (Kinnaird and O'Brien 1996). Crested Black Macaques or Celebes Apes (*Macaca nigra*), tailless, all-black monkeys found only on Sulawesi and listed as Endangered by the *2000 IUCN Red List of Threatened Species*, have declined by 90 percent, due in large part to meat hunting (Kinnaird and O'Brien 1996). An extraordinary turkey-like bird that incubates its eggs in large, leaf mounds, the endemic Maleo (*Macrocephalon maleo*), a Vulnerable species (BI 2000), has declined 75 percent from hunting (Kinnaird and O'Brien 1996). Other endemic species affected by this hunting are the Mountain Anoa (*Bubalus quarlesi*), a CITES Appendix I threatened dwarf buffalo found only on Sulawesi that is on the verge of local extinction, and the threatened, gargoyle-headed

Babirusa (*Babyrousa babyrousa*), a tusked wild pig, whose total wild population is about 5,000 (Kinnaird and O'Brien 1996). Highly organized networks hunt and trade the meat from these threatened species. Some dealers acquire animals on order for traders in North Sulawesi by driving up to 375 miles to buy Babirusa and other meat from forest hunters (Kinnaird and O'Brien 1996).

When native peoples cease hunting for subsistence only and begin hunting for markets, wildlife can be decimated quickly. Even subsistence hunting has been shown to be detrimental in some areas, but when wild animal meat becomes an economic commodity, overhunting usually results. Market hunting in the United States caused the extinction of the Passenger Pigeon (*Ectopistes migratorius*) and Labrador Duck (*Camptorhynchus labradorium*). The Eskimo Curlew (*Numenis borealis*), heavily hunted for meat in the 19th century, is probably extinct as well. The American Bison, Elk, White-tailed Deer and many waterfowl species also nearly disappeared. Following the 19th century slaughters that decimated these animals, laws banning the sale of wild meat from mammals and birds were enacted and remain in force today. In other parts of the world, only extinctions may bring about strong legislation banning market hunting of wildlife.

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Persecution and Hunting

Roman Slaughters

The tradition of killing animals for pleasure has a long history in Asia and Europe. So popular was hunting in ancient Rome that mosaics and paintings often depicted this pastime as a heroic activity. Slaughtering animals was considered a form of entertainment, and people scoured the countryside for bears, Lions, stags and boars to pursue with spears and dogs (Attenborough 1987). As the Roman Empire grew to encompass the entire Mediterranean basin, its citizens traveled throughout the region to hunt and bring back animals to be killed in primitive contests in the coliseums of Rome and other cities. The coliseum games continued for more than 400 years in more than 70 amphitheaters, the largest seating up to 50,000 people on stone benches arranged around a central arena (Attenborough 1987).

Roman emperors curried favor with the public by upstaging their predecessors in killing more animals and producing more spectacular displays of slaughter (Morris 1990). Emperor Titus inaugurated the Roman Coliseum by declaring 100 days of celebration, during which enormous numbers of animals were speared by gladiators. On the opening day, 5,000 animals were slaughtered, and over the next two days, 3,000 more were killed (Morris 1990). The caged animals were kept underground in dungeons where they were not fed, and on the day of the festival, they were hauled in their cages onto lifts that brought them into the center of the arena. As the crowd roared with excitement, drums were beaten, trumpets blown, and the terrified animals were set loose (Attenborough 1987). Sometimes the animals were goaded to attack one another, and at other times, men armed with spears and tridents pursued them around barriers made from shrubs in imitation of hunts in the wild (Attenborough 1987). One arena hunt resulted in the killing of 300 Ostriches and 200 Alpine Chamois (Morris 1990).

Lions, Tigers, bears, bulls, Leopards, Giraffes and deer died after being tormented, stabbed and gored (Morris 1990). Big cats that had been starved were released into the ring where a human slave or prisoner of war was lashed to a post; the animals clawed at the person before they themselves were speared and stabbed by gladiators (Attenborough 1987). In some of the larger slaughters, 500 Lions, more than 400 Leopards, or 100 bears would be killed in a single day (Morris 1990). Hippos, even rhinoceroses and crocodiles, were brought into these arenas, and sometimes gladiators employed bizarre methods of killing such as decapitating fleeing ostriches with crescent-shaped arrows (Morris 1990).

The Roman audiences cheered these brutal slaughters enthusiastically as a rule, but when 20 elephants were pitted against heavily armed warriors, the screaming of these gentle animals as they were wounded caused the crowd to boo the emperor for his cruelty (Morris 1990). This did not stop their use in the games however. These slaughters virtually eliminated large mammals from the Mediterranean area. North African Elephants (*Loxodonta africana*) were exterminated, having been hunted and captured to die in these arenas (Leakey and Lewin 1995). Elephants were also used by the Romans for transport and even conscripted for battle by Hannibal, a Carthaginian general who used them in a deadly march across the Alps, in which all the elephants died of exposure. Romans were probably the key element in the disappearances of the Asian Elephant (*Elephas maximus*) from West Asia as well (Leakey and Lewin 1995).

Prior to the expansion of the Roman Empire, Atlas Bears (*Ursus arctos crowtheri*) lived in the mountains and forests of North Africa, the only bears on the African continent. Named for their last refuge in the Atlas Mountains of Morocco, they were a race of the Brown Bear which is native to Eurasia and North America. North Africa was the species' most southerly distribution. When Romans entered North Africa, they cut the forest habitat of this bear and slaughtered thousands for sport. Others were collected for coliseum combat, where they were attacked by smaller animals, or gladiators wielding axes, spears and other weapons. Over the centuries, the Atlas Mountain forests were leveled for building materials, and colonial landowners used the cleared land for grazing livestock (Day 1981). The

Atlas Bear became restricted to Mount Atlas, where an 18th century French naturalist discovered a fresh skin, upon which the first scientific description was based (Day 1981). Even as late as 1830, the bears were common enough to be captured and sent to French zoos. In 1840, an English scientist concluded that this bear, smaller than the American Black Bear (*Ursus americanus*), was a distinct subspecies. It was stocky, with a short face, blackish-brown, shaggy fur on its back, and orange-rufous fur on its belly (Day 1981). This differentiates it so much from the Brown Bear that modern taxonomists might consider the two distinct species. Although Atlas Bears became increasingly rare, they received no protection from hunting, and the last of these bears were shot around 1870 (Day 1981).

Herodotus and Aristotle, philosophers of ancient Greece, wrote that Lions once lived in that country (Attenborough 1987). Two thousand years ago, the range of these big cats extended eastward in a continuous band to India and Pakistan and throughout the African continent. The Lion disappeared at an early time from Italy and Greece after being hunted and captured by the thousands for gladiator spectacles. When European Lions had been killed off, Romans turned to North Africa. The Barbary or Atlas Lion (*Panthera leo leo*), once distributed through much of the region north of the Sahara, fell victim to hunting and Roman Coliseum games. Known for its enormous mane, which covered virtually half its body, the male Barbary Lion was one of the largest of all races of Lions (Day 1981). It was also the nominate, or first subspecies named. This massive animal weighed as much as 500 pounds and measured up to 10 feet long from the tip of his nose to the tip of his tail (Day 1981). After centuries of hunting, persecution and habitat loss, these Lions withdrew to remote forests, where the last of them were systematically hunted down. Arabian tribesmen in Tunisia and Algeria chased them for sport, and later, French colonial governments paid bounties for their skins; by the 19th century, hunters had exterminated the last of the lions in Algeria (Day 1981). Government lists recorded the bounty fees paid, with fewer each year; only one skin was submitted for payment in Algeria in 1884 (Day 1981). Their final refuge, like the Atlas Bear's, was the wilderness forest of Morocco's Atlas Mountains, where hunters killed the last one around 1922 (Day 1981). Although officially extinct, some of these Lions may still survive in captivity. Certain circus and zoo Lions resembling the original Barbary Lion have been identified, and an effort is being made to gather a breeding colony of these animals. Whether they are, in fact, direct blood lines from the original North African Lions remains to be seen.

By the 13th century, Lions had been eliminated in the eastern Mediterranean; they disappeared from Iraq, Iran and Pakistan by the 1800s (McClung 1976). The last Lion in the Saudi Arabian peninsula was killed in 1923. For most ancient cultures of the Middle East and West Asia, killing one of these great cats, especially a large male, was considered a heroic deed worthy of being recorded in paintings and mosaics. Many such art works remain from Assyrian and other West Asian cultures. By the mid-19th century, Asiatic Lions (*Panthera leo persica*) had become confined to India, but were still widespread in that country (McClung 1976). During the last half of the 19th century, however, Indian Lions came under siege by British Colonial officers, who traditionally proudly took a Lion pelt back to England; a single hunter boasted of shooting 300 Indian Lions in 1860 (IUCN 1978). Under such pressure, Lions disappeared from all of India, save the Gir Forest in the southwest, by 1884 (IUCN 1978). In 1900, protection was finally accorded the last of these Lions, when their populations had been reduced to fewer than 100 animals (McClung 1976). Today, the Gir Forest Lions number a few hundred animals, all that remain of these proud cats on the Eurasian continent. Confined to a habitat that was rapidly being whittled away by villagers cutting firewood, and overgrazed by livestock, the Gir Lions are now protected in the Sasan Gir National Park of western India where, in recent years their population has increased.

Hunting by Romans and later peoples, combined with capture for the colosseum games, devastated the wildlife of North Africa and the entire Mediterranean region. Large predators, as well as deer and other ungulates, disappeared altogether or become endangered. Few conservation programs exist to protect remaining populations from hunting and persecution.

Predator Prejudice

The Roman tradition of persecuting predators spread throughout Europe and intensified in proceeding centuries, reaching superstitious depths in the Middle Ages. Beliefs that fiwerewolvesfl existed resulted in the persecution of wolves in Europe and Russia that continues today. Fairy tales are still recounted to children, in which wolves and bears are depicted as voracious killers. These stories, especially those by the Grimm brothers, frighten small children with tales of wolves, that pursued and ate small children and adults alike. "Little Red Riding Hood" and other stories instilled horror and hatred of predators. In Russia, the destruction of wolves was considered a great benefit to people, as well, with folklore embodied in tales such as "Peter and the Wolf." Persecution of wolves in that country continues to this day. With the spread of domestic livestock throughout Europe, official programs were instituted to destroy wolves (McIntyre 1995). Wolves were not the only animals killed in these programs. Lynx and Brown Bear were also eliminated from all but the most remote areas of Western Europe.

When Europeans settled in America, they brought these prejudices with them, treating native predators as vermin. Most colonies passed laws similar to Massachusetts' 1630 law requiring that "every English man that killeth a wolf . . . shall have allowed him one penny" (McIntyre 1995), and South Carolina's 1695 "Act for Destroying Beasts of Prey," which mandated that all Native American braves be required to bring in one skin of a wolf, panther, or bear, or two Bobcat skins each year. If he failed to do so, he would be "severely whipped," but if more than one skin was provided, he would receive a reward (Nowak 1972). In the East, these programs systematically killed off Gray Wolves, bears and Cougars. Large predators were effectively eliminated in the eastern states by the early 1800s, except for the Black Bear, which became greatly reduced in range and numbers.

The US government ran predator control programs throughout the country. Traps and poisons were the major tools used. Poison was liberally spread over most of the West. Thallium sulfate, strychnine, Compound 1080, and cyanide were distributed in great quantities, killing not only wolves, bears, and Coyotes, but foxes, weasels, ferrets, eagles and other birds. Any animals that ate the poisoned bait died, as well as those feeding on their carcasses. All these poisons caused a painful death, and most killed slowly. Poisoned animals could take hours to die from Compound 1080, and sometimes days after ingesting thallium sulfate. Strychnine, an extremely painful poison, can make water supplies lethal, killing humans, dogs and livestock. The wild predators that consumed Strychnine would vomit while dying from convulsions. Their bodies spread more poison, which remained toxic for a year or more.

Trapping was equally indiscriminate in its victims. Irrational prejudices against predators resulted in the total extermination, even in remote wilderness areas, of America's wolves and almost all its bears through bounty systems, federal subsidies and government control programs. Trappers and poisoners combed the countryside, randomly placing poison and traps.

Prejudice against predators affects a wide spectrum of animals, from foxes and bears to bats and birds of prey. Although the number of species that have become threatened as a result of control programs and random killing is less than those threatened by habitat destruction, the ecological consequences have affected a host of species within their habitats. These animals have co-evolved with their prey, the wolf making the deer fleet; wild cats making gazelles, zebras and hundreds of other ungulates agile. Although there is dispute as to the effect that predators have on the populations of their prey, overpopulations of deer and other ungulates have occurred in many parts of the world where predators have been eliminated. When ungulates overpopulate, they tend to overgraze their habitats, eliminating many types of vegetation, as well as birds and other wildlife dependent on that vegetation for feeding and habitat. Thus, thousands of species may be adversely affected when predators are destroyed.

Many species of snakes, as well as small carnivores such as foxes, eat large numbers of rodents, performing

important roles in preventing population explosions of these prey animals. Bats, as the most important predator of insects, control insect populations, as documented by many scientific studies. These mammals, although more abundant in number and diversity than carnivores, have declined radically in recent years, as evidenced by the enormous number now listed in the *2000 IUCN Red List of Threatened Species*. From a humane point of view, predator control has brought out the worst in human character, suppressing reason and compassion to allow fear and hate to dominate. As science has learned more about the importance of predators, and they are being protected and reintroduced in a growing number of areas in the world, prejudices remain, as do centuries-old ways of raising livestock that involve killing predators. These latter problems need to be addressed with the same vigor that has elevated predators to their rightful place at the top of their food chains in the eyes of conservationists and scientists.

Wolves, Wild Dogs and Foxes

Wolves have suffered more inhumane treatment and loss of range and populations than any other predator. The history of their survival and disappearance in various parts of the world is a reflection of the overwhelming importance of people's attitudes toward animals. When emotions, especially fear and negative superstition, rule people's minds, wolves can be destroyed on the basis of ignorance about their real threats to people and livestock. On the other hand, when people are aware of biological facts about the wolf and its ecological role, behavior, value to ecosystems, and the truth about its history of not attacking people, prejudices tend to dissipate. Native Americans had a natural affinity and respect for wolves, calling them "brother." The wolf's very survival as a species depends on its being treated with tolerance and respect. Gradually, this is happening in many parts of the world. Education and a change in government attitudes in many countries are needed to conserve this species, along with better ways of raising livestock.

Wolves, Wild Dogs and Foxes: Page 1

Prior to European settlement of North America, two wolf species lived throughout the forests of the East: the widespread Gray Wolf (*Canis lupus*), the same species that is native to Eurasia, and the Red Wolf (*Canis rufus*), a uniquely American species of the Southeast. Some biologists estimate that there were 2 million wolves on the continent at this time. European settlers entered the American wilderness and set about killing off these animals. The book, *War Against the Wolf. America's Campaign to Exterminate the Wolf*, by Rick McIntyre (1995), chronicles the history of this extermination program, based on historical and modern documents. Colonists dug pit traps and filled them with vertical stakes, which impaled wolves falling onto them. When hunters found an animal in the pit, they would leap in and ham-string the cowering wolf. John James Audubon described a farmer who captured wolves in a pit trap, severed the tendons in their hind legs, then tossed the crippled animals into a pack of dogs which tore them

apart (McIntyre 1995). The new colonists and their professional hunters set toothed traps that held the animal's leg while the teeth broke through its skin, wounding and breaking bones. Some who captured wolves cut off the lower jaw and turned the animal free to starve (Laycock 1990). Others set them afire, or started forest fires to rid the woods of wolves (Laycock 1990). Strychnine and thallium were placed in meat baits. Wolf pups were ripped apart by dogs, stomped to death, or burned alive in their dens. One predator hunter threw baited fish hooks, attached to lines, into wolf dens, waited until the pups swallowed the hooks, which embedded in their stomachs, then dragged them out of the den and killed them (McIntyre 1995).

Europeans were convinced that wolves hunted humans, even entering towns to kill children as they slept. In truth, wolves are neither ferocious nor killers of people. No case of a non-rabid North American wolf killing a human has ever been documented (McIntyre 1995, Nowak 1999). Very passive when trapped, they do not even attack the trapper as other predators might. Native Americans took wolf pups out of dens for pets without ever being attacked by the parents.

Red Wolves, named for their reddish-brown coats, had other color phases as well. Prior to their near-extinction, they exhibited a range of colors from black to gray and brown. The genes for these color phases were eliminated along with the wolves themselves in predator-control programs. Originally, this wolf inhabited the United States as far west as Oklahoma and eastern Texas, north to Indiana, as well as the southeast. The Red Wolf is the only surviving wolf that evolved in North America. This species and its ancestor, *Canis edwardii*, had been resident in forests as far north as Pennsylvania since the middle Quaternary epoch (Nowak 1979). Dr. Ronald Nowak, an expert on wild canids, maintains that the Red Wolf is a far more ancient species than the Gray Wolf. The latter species is thought to have evolved more recently in Eurasia, during the early Pleistocene, and migrated into North America across the Bering land bridge that linked the continents (Nowak 1979).

Weighing only 20 to 40 kilograms (44 to 88 pounds), and 660 to 790 millimeters (26 to 31 inches) tall at the shoulder, the Red Wolf is larger than the Coyote (*Canis latrans*), but smaller than the Gray Wolf. Mating for life, it breeds in February or March, producing two to six pups in March or April. The pair dens in hollow logs or along banks of canals or ditches. These wolves did not usually form packs, but were most often seen in pairs or small family groups. They were systematically trapped, shot and poisoned out of their range. From the 17th century onward, in state after state, these wolves were exterminated to the last animal, pushing this species toward extinction. Federal predator-control programs took some 50,000 Red Wolves from 1937 onward, until they were virtually extinct in the wild (Laycock 1990). It was not until 1962 that this wolf's highly endangered status received any attention from biologists and wildlife officials. Still, no action was taken to stop state trapping and predator-control programs for another 11 years.

By the 1970s, the Red Wolf had been completely exterminated, except a small population that survived in one county in southwestern Louisiana and in adjoining areas of eastern Texas (Carley 1975). Coyotes had moved into the range of the Red Wolf and interbred with some of the last members of the species. This hybridization spelled the demise of wild Red Wolves. It has been suggested that this interbreeding occurred only because Red Wolves had become so rare that they were unable to find mates of their own species. A live-trapping program to capture the last, pure-blooded specimens, as the only way of saving the species, began in 1973 in Texas, funded by the US Endangered Species Act (ESA). Fewer than 100 animals remained. After capture, X-rays were taken of these animals' skulls to determine which were pure-bred and which were hybrids, based on their skull shape and dimensions.

A number of these hybrids, as well as the pure-blooded Red Wolves, were in poor health from mange, heartworm and other parasites when captured (Carley 1975). Their last attempt to survive in the wild had obviously been a difficult one. Their remaining habitat in Texas and Louisiana had become a mosaic of agricultural and residential development, leaving little natural forest. Moreover, they were under constant threat from trappers and hunters. After five years of live-trapping, only 40 pure-blooded Red Wolves were identified, and they were sent for captive breeding at the Point Defiance Zoo in Tacoma, Washington. No further Red Wolves were found, and in 1979, Howard McCarley and Curtis Carley of the Red Wolf Recovery Team, authorized under the US Endangered Species Act, announced in a status

report, "Recent findings indicate that the only extant subspecies (*Canis rufus gregoryi*), once occurring from eastern Texas to eastern Mississippi, for all practical purposes is extinct in the wild" (McCarley and Carley 1979). The other subspecies of the Red Wolf, the Florida Red Wolf (*Canis rufus floridanus*), had become extinct by 1917 (Day 1981). So many wolves of the Florida race, which once ranged into Georgia and southern Tennessee, were black, that this wolf was originally named the Black Wolf. This genetic strain is now lost.

Of the 40 captive Red Wolves, 14 were selected to form the nucleus of a Fish and Wildlife Service-sponsored captive-breeding colony (Nowak 1999). In 1977, offspring were successfully produced, and by 1989, there were 83 descendants, and the last surviving wild-caught Red Wolf died (Nowak 1991). In 1993, the captive colony consisted of more than 187 animals in 31 breeding facilities. By 1995, there were 289 living descendants from the original wild Red Wolves, the majority in Point Defiance Zoo in Tacoma, Washington (Nowak 1999). In the mid-1980s, reintroduction programs began with the release of several of the captive-bred wolves to the wild. This was the first time the American government had ever sought to introduce and protect wild populations of wolves, instead of eliminating them. Since the Coyote is now present throughout the Red Wolf's original range, attempts were made to find reintroduction areas without Coyotes to prevent hybridization and competition. In 1987, four pairs of Red Wolves were reintroduced into the 120,000-acre Alligator River National Wildlife Refuge, an island in North Carolina without resident Coyotes. A pair released on Bulls Island in Cape Romain National Wildlife Refuge in South Carolina produced two pups in 1988. These pups were captured and released in the Alligator River Refuge in 1989. Another pair, introduced to Horn Island off the Mississippi Coast, produced seven pups in May 1989. By the close of 1993, 46 to 60 animals survived in these newly wild populations by Fish and Wildlife Service counts.

In 1991, a pair of Red Wolves and their two pups were set free in Great Smoky Mountains National Park in Tennessee. Jan DeBlieu, a writer on endangered species, witnessed the release of the wolf family (McIntyre 1995). This area has resident Coyotes, which arrived in the mid-1980s, and the interaction between the two species will be closely watched. Several Coyotes and the adult Red Wolves have radio transmitters and were tracked by a number of biologists after their release. DeBlieu was present when, soon after their release, the male and pups traveled 2 miles away from the female, who lay quietly in a field. Suddenly the researchers heard the prolonged, low howl of the male wolf and high-pitched yaps of the pups, a song "not heard in the Smokies for one hundred years" (McIntyre 1995). They were calling the female, who ran toward them. This national park receives 8.6 million visitors a year--more than any other park in the system. The visitors tend to stay near roads, however, and most of the park is roadless wilderness. Prey is abundant, and both the adults and pups began catching rodents and rabbits, hunting at dawn to avoid tourists during the day (McIntyre 1995). By late summer 1994, there were seven Red Wolves in Great Smoky Mountains National Park. Two more family groups were released the following year, but the available prey in Great Smoky Mountains National Park is limited in the mountainous terrain (Rancourt 1997). As many as 26 wolves lived in the park in 1997 (Rancourt 1997). A few pairs have produced young.

For the most part, these reintroduced wolves have survived with few conflicts with local people, mainly due to the extensive education programs and hearings held by the Fish and Wildlife Service in each area prior to releases. Some private landowners in North Carolina became apprehensive about the potential threat to children and livestock. The Fish and Wildlife Service has paid claimants for losses even when no proof was submitted that it was, in fact, a wolf at fault. One livestock owner admitted that the Red Wolves had become "good neighbors." Yet even these limited reintroductions have provoked resentment in some local communities which harbor ancient prejudices about wolves. The North Carolina state legislature passed a law early in 1995 that defied the US Endangered Species Act, allowing people to kill wolves that attacked livestock. The Fish and Wildlife Service accommodated these concerns by changing its policy in April 1995 to allow killing of Red Wolves thought, but not proven, to be attacking livestock in North Carolina and Tennessee. One of the first wolves killed, male number 464, was shot in 1995 in North Carolina by a landowner who caught him digging under his dog's pen. This wolf had been released the previous year near Alligator River National Wildlife Refuge, but prey was scarce, so Fish and Wildlife Service personnel recaptured him and freed him on the mainland. Number 464 had not been guilty of preying on livestock.

Further incidents between residents and Red Wolves occurred in 1997 and 1998, with wolf pups that were attempting

to disperse into new territory being trapped. One young wolf that had been taken in a leghold trap in North Carolina was rescued by the Fish and Wildlife Service and returned to a penned enclosure in 1998. The local county representative stated that wolves were unwanted intruders and would be dealt with by residents. This does not bode well for reestablishment of these wolves.

If the Red Wolf survives this irrational prejudice, it may reoccupy many of its original haunts. The threat of hybridization with the Coyote will remain, however, and without corridors of habitat to link reintroduced populations, these wolves risk becoming inbred. With education of the public, one day the Red Wolf may be restored as a natural predator, benefiting its prey and ecosystem.

Wolves, Wild Dogs and Foxes: Page 2

Unlike the Red Wolf, Gray Wolves traveled in large packs in the Great Plains of the West. Many of the wolves painted by George Catlin, the great 19th-century artist of Native Americans and wildlife of the Plains, were beige or pure white, as are many of the wolves of the grasslands of northern Canada. Early hunters killed wolves for their pelts by trapping, poisoning and shooting. Many were used for target practice in the open country. When livestock ranchers took over huge tracts of land in the West, the Gray Wolf became a target for total extermination. Cowboys often roped wolves and dragged them to their deaths across rough ground (McIntyre 1995). Federal trappers used even more brutal killing methods (McIntyre 1995).

James Josiah Webb, who wrote a memoir of events in the Santa Fe, New Mexico, area from 1844 to 1861, recounted that two men conducted a wolf-killing operation by spreading strychnine bait placed in chunks of bison meat around the prairie. The number of wolves that once inhabited the region was so dense that they found 64 dead wolves within 1.5 miles of their camp in a single day after a poisoning; they bragged that they earned $4,000, an enormous sum in those days, by selling wolf pelts (McIntyre 1995).

As wolves were exterminated in one state or territory after another, a few of these intelligent animals managed to escape traps, guns and poison, earning the label of "outlaws." These wolves ranged alone or in small packs, and in the last days of the western wolf, some trappers spent months or years in determined pursuit of them. The ability of these wolves to elude their persecutors were truly amazing. One of the most famous such cases was described by Ernest Thompson Seton, an English artist and writer, in *Wild Animals I Have Known* (1899). Based on fact and documented by photographs, it concerned Lobo, an enormous wolf, called "The King" by Mexican residents who lived near a huge cattle ranch in northern New Mexico. For many years in the 1890s, Lobo led a pack of five wolves. He had a distinctive, deep howl that ranchmen recognized among the howls of the other wolves. He was by far the largest wolf in the pack and exceeded the size of other wolves in the region. Whereas most wolf paws measured 4 3/4 inches, Lobo's were 5 1/2 inches long. His mate, whom the Mexicans called Blanca, was a large, magnificent white wolf.

These wolves, like many others of the West during this period, had been deprived of their natural prey, White-tailed and Mule Deer and Elk, which had been hunted out by settlers and replaced with livestock. The wolves turned to livestock as the only large prey available and, in doing so, became the target of ranchers' wrath. Western ranchers, like many livestock owners in Europe, believed that they should be able to release cattle to roam free without herding them into shelter at night. This situation had existed in Western Europe after large predators were eliminated from all but the most remote areas. In their new ranches, allocated to them by the government, ranchers sought to recreate the European model. This required the destruction of large predators.

Lobo and his pack refused to eat dead animals that they encountered, apparently to avoid poison, and survived on calves and sheep that they killed themselves. When Lobo and his pack killed a cow, ranchers immediately put poison in the carcass. But when the wolves returned the next day to eat, they somehow knew which parts of the carcass were

poisoned, and pulled out the poisoned chunks, throwing them aside, eating only the unpoisoned portions. Lobo also avoided the traps set for him and hid from hunters on horseback who pursued him. Trappers came from great distances to claim the high bounty on Lobo, but all failed to kill him. Ernest Thompson Seton decided to try to kill Lobo himself for the $1,000 bounty. He scattered poisoned baits, covering the human scent with other odors, and the following day, found that one after another of the baits was gone. Assuming that he would come upon the body of Lobo, he was surprised to find his five baits in a pile. Lobo had picked them up, one after another without eating them, and left them as a message to Seton. Seton obtained special steel jaw leghold wolf traps and set them in concealed places in Lobo's territory. When he came out to check the traps, he found Lobo's tracks leading from trap to trap. The canny wolf had discovered each of the traps during the night, scratching earth away to reveal the chain and trap, continuing from trap to trap until he encountered one in the center of the trail. Lobo then retraced his steps, placing each paw exactly in its old track until he found no more traps, using his paw to flip stones and earth clods to spring every trap.

Seton finally succeeded in trapping Blanca by setting hidden traps among parts of a cow carcass and covering the area with Coyote scent. Lobo avoided the traps, but Blanca made a fatal error and blundered into one. When Seton and the others found her dragging the heavy trap, she turned to fight, howling across the canyon. Lobo howled back, while Seton and the others brutally killed her. Throwing lassos over her neck and holding the ends of the ropes, they galloped horses in opposite directions until her body was torn apart. When he wrote of the event years later, Seton (1899) called the killing a tragedy. They heard the howls of Lobo for days afterward. Seton described it as having "an unmistakable note of sorrow in it, now. It was no longer the loud, defiant howl, but a long, plaintive wail." When they found Lobo's tracks at the spot where Blanca had been killed, Seton reflected, "Now, indeed I truly know that Blanca was his mate."

Soon afterward, Lobo came near the ranch house. His tracks showed that he had galloped about in a reckless manner before he blundered into a trap set in a pasture. He was able to pull out of it, but Seton then set 130 steel jaw leghold wolf traps in groups of four on every trail leading into Lobo's home canyon, and dragged Blanca's body around the area to leave her scent. He even removed one of her paws, with which he made a line of tracks on the soil covering each trap. Within days, Lobo was caught with all four legs in a trap set, having followed Blanca's scent and forgetting all caution. When Seton approached the trapped wolf, Lobo managed to stand, in spite of severe injuries, and howled his deep call, but no members of his pack responded. Seton and others wrapped ropes around his neck, put a stick in his mouth and lashed his jaws closed. His feet were tied, and when he was placed on Seton's horse, he refused to look at any of his captors. At the ranch, Seton placed a collar around his neck, secured him to the pasture with a strong chain, and Lobo lay calmly, gazing across the prairie.

When Seton came out the next morning, Lobo was dead. On measuring his body, Seton found that Lobo weighed 150 pounds and was 3 feet tall at the shoulder. He was one of the largest wolves ever trapped in the Southwest. The largest Gray Wolves are native to northern Canada and Alaska and weigh up to 176 pounds, but most wolves of the Southwest were far smaller and lighter (Nowak 1991). Scientists who measured the skulls of the pair estimated that Lobo was 4 to 5 years old when he was killed, and Blanca was 7 (McIntyre 1995). Photos of Lobo and Blanca caught in traps are reproduced in Rick McIntyre's 1995 book, *War Against the Wolf*. Lobo and Blanca were exceptional specimens, and their slaughter represented an irreplaceable genetic loss. The treatment they received will remain a blot on human "kind." Lobo was killed on January 31, 1894, near Currumpaw, and his pelt is kept at the Ernest Thompson Seton Memorial Library and Museum at the Philmont Scout Ranch near Cimarron, New Mexico (McIntyre 1995). This experience changed Seton's attitude, and he expressed strong feelings of guilt in his description of his treatment of these wolves.

Government programs did not reflect Seton's newfound sympathy for wolves. In fact, predator-control programs intensified in the early years of the 20th century. Ranchers convinced the federal government to launch an all-out attack on predators, primarily wolves. The Forest Service and the Bureau of Biological Survey used poisons and traps to kill adult animals and many cruel methods to kill the pups in dens in their efforts to try to exterminate the wolf. In 1907 alone, the Forest Service killed more than 1,800 Gray Wolves and 23,000 Coyotes, among other animals

(Laycock 1990). After the US Congress authorized the first substantial appropriation for hiring government hunters in 1915, federal wolf-control programs achieved an unprecedented level. Hundreds of agents combed the most remote wildernesses, spreading poison even where no cattle or livestock grazed. A point system was established; the highest number of points, 15, was accorded for killing a Mountain Lion or a Gray Wolf (Laycock 1990). Hired hunters earning high point totals made the Honor Roll, while others might be fired; they were expected to kill virtually every predator in their assigned area (Laycock 1990).

Within a few decades, many thousands of Gray Wolves had been killed. They were eliminated from more than 95 percent of their range in the lower 48 states by the 1930s (Robbins 1997). A few wolves, using their intelligence and survival senses, managed, like Lobo and his pack, to survive somewhat longer, but they were killed in the end. The Custer Wolf, a large female also known as "Old Three-Toes" because she had lost a toe in a steel jaw leghold trap set by a government trapper, became as infamous as Lobo and Blanca. After her mate and pups were killed, the Custer Wolf survived until caught in a trap that became snagged on rocks (McIntyre 1995).

Vernon Bailey, a biologist with the US Biological Survey, the government agency that later became the Fish and Wildlife Service, conducted wildlife and plant studies as well as predator-control programs. He noted early in the century that the Biological Survey had conducted "the most systematic and successful war on these pests ever undertaken" (McIntyre 1995). The loss of virtually all wolves in the vast area encompassing the lower 48 states may be the most devastating predator-control campaign in history.

If not for the fact that the predator-control programs of the territorial and provincial governments of Alaska and Canada did not succeed in totally exterminating the wolf, the species might be extinct on the continent. Although wolves were persecuted and trapped for their fur in the latter areas, they survived in the far north and in the eastern forests of Ontario and Quebec and have now reoccupied most of their original range in Canada.

The Gray Wolf is able to adapt to a wide variety of habitats and climates, whether searing deserts, shrublands, grasslands, forests of all types, frozen tundra or even marshlands. It had the largest range of any terrestrial mammal on Earth, other than humans (Nowak 1999). Wolves had lived for thousands of years on the continent, their environment and prey altering drastically through the Ice Ages, needing only the presence of large prey to survive. Wolf intelligence, in fact, exceeds that of the domestic dog, which has a brain 31 percent smaller (Busch 1995). In spite of the wolf™s survival abilities, the fragmentation of packs by predator-control agents prevented them from hunting normally and hastened their disappearance soon after control methods began. This need to live in a pack for hunting and companionship made the species vulnerable to extermination. When persecuted, Gray Wolves do not desert one another, and many cases have been documented of wolves sacrificing their lives in an effort to save a pack mate. This altruistic trait also contributed to their extermination. The traits that humans most admire about domestic dogs were inherited from the wolf--loyalty, intelligence, playfulness and affection. Wolf pups were first domesticated by hunter gatherers tens of thousands of years ago, and even after selective breeding by humans in the intervening centuries, they still retain many of the wolf's best qualities.

Wolf packs have a lead pair, known to biologists as the alpha male and female, who are the only members of the pack that produce cubs. They mate for life, and dominate other wolves in the pack. They are usually the fittest and largest. Other pack members challenge for leadership, which can result in a change in the alpha pair. The entire pack, which includes adult females and males and pups from the previous year's litter, cares for the pups, ensuring that the strongest pass on their genes to future generations. Young unmated females and males "baby-sit" the pups when the alpha pair and the rest of the pack are out hunting. When the pups are about six weeks old, their baby-sitters spend hours with them in wrestling matches, games of tag and other rambunctious activities. Within the pack, wolves are extremely friendly and devoted to one another, barking and yipping with delight on meeting, and before and after hunts. They howl at night, communicating with other wolf packs which howl back. Bonds between wolves, especially mated pairs, are very strong, as illustrated by the saga of Lobo and Blanca, and many other cases of wolves in apparent mourning for lost mates have been documented. For many days, one male Mexican wolf, howling plaintively, followed a government trapper who had killed the wolf™s mate and carried off her pelt.

Other species of canids show similar behavior. The African Wild Dog (*Lycaeon pictus*), a highly endangered wild canid, hunts on the African plains in even larger packs than Gray Wolves, numbering up to 26 animals, yet only one female in the pack has pups. The alpha female might have 16 pups, and if another female in the pack has a litter, the alpha female will steal the cubs and nurse them, even if the litter size reaches 20 or more. Fewer than 5,000 of these beautiful animals, sometimes called Painted Wolves because of their black-and-yellow spotted coats, remain in the wild, and they are in steep decline (Nowak 1991). In Zimbabwe, where there are only about 300 to 500 animals, they are still persecuted by farmers. Even in national parks, they often lose prey when chased off by Spotted Hyenas or Lions.

The ecology of the Gray Wolf has been studied since the 1940s, revealing it to be completely different from the prejudicial folklore of Europe. Adolph Murie, one of America's greatest biologists, conducted studies of wolves in Mount McKinley (now known as Denali) National Park, where they were neither persecuted nor hunted. In his study, *The Wolves of Mount McKinley* (Murie 1944), he revealed: "It appears that wolves prey mainly on the weak classes of sheep, that is, the old, the diseased, and the young in their first year. Such predation would seem to benefit the species over a long period of time and indicates a normal prey-predator adjustment in Mount McKinley National Park." By examining the carcasses of Caribou and other mammals killed by wolves in the park, Dr. Murie found that most were in poor physical condition. Wolf packs test their prey by isolating and then chasing individual animals to detect weaknesses, and the majority of their chases do not result in a kill.

In spite of more than 50 years of biological studies of wolves that have shown them to be a positive rather than a negative influence on their prey, there are still many who disagree. Predator-control programs have been authorized in Alaska, Canada and parts of Eurasia in misguided attempts to protect deer, Elk, Moose, American Bison and Caribou. A trophy hunting organization, Safari Club International, paid the British Columbia government to kill wolves in that province (Williams 1991). The real motivation for these eradication programs is often to promote artificial increases in populations of ungulates, such as Moose, Caribou and deer, for sport hunting.

Over the ages, prey species of wolves have evolved to survive their attacks by becoming faster and stronger. The largest and healthiest deer on the North American continent have been found in areas where wolves are resident predators. The number of wolves in a pack varies according to the size of the prey: packs of up to 15 are needed to bring down bison, while packs of seven or fewer hunt deer (Nowak 1999). Wolves hunting large prey run in shifts, with tired members of the pack replaced by rested wolves. They will sometimes need to run for many miles after Caribou, Moose, American Bison or deer before they succeed in singling out one they are able to bring down; an average of only one in 10 chases is successful. Native Americans have always been aware of the important relationship between the wolf and its prey. The Keewatin Inuits have an ancient saying: "The caribou feeds the wolf, but it is the wolf who keeps the caribou strong" (Busch 1995). The healthiest members of each prey species are able to fend off wolf packs, and only in unusual circumstances can wolves kill them. For the vast majority of prey species, wolves sense weakness in their prey, evidenced by body stance, uncoordinated movements, the smell of wounds or, most often, by their lack of endurance when being chased (McIntyre 1995).

When wolves are hunted out of an area with deer and other ungulates, the latter animals often increase in numbers to such great levels that they strip their habitat of vegetation. The overpopulation of White-tailed Deer in many parts of the northeastern United States, especially in suburban locations, has resulted from a lack of natural predators. Their absence has created a major imbalance in eastern forest ecosystems, where they have become so numerous that they consume young trees and new growth on mature trees.

Wolves, Wild Dogs and Foxes: Page 3
Although Gray Wolves were completely eliminated from the eastern states south of Canada and east of Minnesota by 1930 (McIntyre 1995), a few remnant populations survived in northern Minnesota and northern Montana. The first US Endangered Species Act in 1967 listed all wolves in the lower 48 states and Mexico as Endangered. In 1973, another Endangered Species Act was enacted, replacing the 1967 Act. Five years later, the category for the wolves of Minnesota was changed to Threatened. In subsequent years, wolves were reintroduced to the southwest, Wyoming, Montana and Idaho, listed as Threatened experimental populations. All other wolves south of Canada are still listed as Endangered. Wolves have wandered from Minnesota and south from Canada to neighboring Wisconsin and Michigan, with about 50 wolves living in each state (Nowak 1999). Prior to eradication programs beginning in the 19th century, between 9,000 and 16,000 wolves were estimated to have occupied these three states (Savage 1996). Bounty programs killed 150 wolves a year in Minnesota alone between 1949 and 1954, and this state did not withdraw its bounty until 1965; Wisconsin stopped bountying wolves in 1957, and Michigan in 1960 (Savage 1996).

The wolves of Minnesota have gradually increased in range in the past 30 years, but they remain thinly distributed in the northern portion of the state. State regulations allow them to be killed if found preying on domestic livestock, with little or no proof of depredation. Minnesota has a compensation program for livestock owners but does not attempt to relocate wolves, even though depredations have occurred on only 1 percent of farms in that state (Savage 1996). In Wisconsin, large areas have been closed to Coyote hunting during the deer season, which has greatly decreased wolf mortality there, since many wolves were shot--either mistakenly or intentionally--by hunters (Savage 1996). Unlike Minnesota, Wisconsin relocates wolves found preying on livestock and compensates owners of livestock killed by wolves; Michigan's Upper Peninsula, where wolves are found, has no livestock (Savage 1996).

Although many Minnesota residents consider wolves to be threats to livestock and resent the protection they receive from the US Endangered Species Act, for others, they are a thrilling symbol of wilderness and the America that existed several hundred years ago. Ellen Hawkins and her husband Gary live in a wilderness cabin surrounded by Superior National Forest land, prime wolf country in northern Minnesota. Because they are avid wildlife watchers, they put out food for birds, foxes, Fishers, Martens and weasels, and state officials bring the couple road-killed deer which they place in a clearing 200 yards below their house for wildlife to feed on. They saw wolves very rarely and felt lucky to hear their howls or find their tracks (Hawkins 1988). One December day, they spotted a wolf feeding on a deer carcass on their property and noticed that he was wearing a radio collar, placed by the Fish and Wildlife Service to track many of Minnesota's wolves.

Their excitement at seeing the wolf, who brought "magic to the place," dimmed when they realized he was injured. He limped, holding up his right front foot, and they saw him fall in the snow (Hawkins 1988). He kept his tail down, a sign of subservience and fear, and moved stiffly and awkwardly. He spent five days feeding on the deer, lying in the snow near it, and seemed weaker each day. On the sixth day, he disappeared from the clearing, and in the middle of the night, an amazing event occurred: "We were confronted by his face pressed against our window" (Hawkins 1988). As they stood gaping at him, they heard him thump his nose on the glass, still staring at them. The wolf then went to another window, and they found themselves again eye-to-eye with him. He had climbed a snowdrift onto their greenhouse roof and now sat leaning against the window, looking back over his shoulder at them. The Hawkinses found some chicken and tossed it onto the roof next to him, while offering him a pan of gravy. The wolf looked at the food, and then at them, but did not eat.

The temperature was 25 degrees below zero F., and they decided the wolf needed warmth. Gary got a blanket and put it around the wolf, who jumped at first, and then quieted down. His passive response made them think that he should be brought indoors. They got an old quilt, and Gary picked up the sick wolf, carrying him into their living room. The wolf was somewhat dazed, but hardly moved. They called their neighbor, who came 12 miles to see the frail and sickly wolf sitting near the stove in their living room. Uninterested in food, the wolf looked about and seemed to warm up, leaning against the stove until his fur singed. They saw that he had lost part of his front foot, and they heard him wheezing as he breathed. Within minutes, his condition deteriorated, and he began pawing at his mouth. His wheezing grew into a "terrible, deep gurgling" (Hawkins 1988). Gary moved close to the wolf and began to stroke its

head. The wolf stood up with effort, but then slumped down to lie beside the stove. Gary removed the collar so that the wolf could breathe more easily, and they saw that it had a number--6530--with the address of the Fish and Wildlife Service. The wolf suddenly staggered into the middle of the room, spasmed and struggled for breath. Gradually they saw his eyes become unfocussed, and the light faded out as he died (Hawkins 1988).

They later learned that Wolf 6530 left his pack when he was nearly 2 years old and wandered for eight months before he returned to his family. He stayed with them only two months before walking 40 miles to another hunting area. Finally, fatally ill, he came to the Hawkins' house, which was 45 miles from his pack. An autopsy revealed that he had died of a fungal pneumonia, the first such case of wolf mortality. The disease may have been brought on by stress and lack of nourishment (Hawkins 1988). Although his coat was thick, he was emaciated, weighing only 55 pounds. At his age he should have weighed at least 75 pounds. He had a tear on his lower lip, had lost three pads on his right foot, and one pad was mutilated on his left foot (Hawkins 1988). A biologist with the Fish and Wildlife Service was contacted about Wolf 6530 and, in his opinion, the wolf's foot wounds were probably the result of getting caught in a fox trap and dragging the trap about until its toes rotted off (Hawkins 1988). As long as he was dragging the trap, he was unable to hunt with the pack, and this may have explained why he was forced to wander in search of carrion.

Many Minnesota wolves and those dispersing to neighboring states and southern Canada have been trapped in leghold traps. In fact, Wolf 6530's brother had been killed by a trapper in Ontario, 115 miles to the northeast, at the age of 18 months (Hawkins 1988). Wolf 6530 had suffered for many months, and his life ended prematurely. Wolves can live 10 years or more in the wild. Only because he had turned to people during his last days did his story come to light. Ellen Hawkins reflected on the extraordinary event: "We'll never know what motivated him to come our way. I can only say that I'm grateful to Wolf 6530 for sharing his last, desperate moments of life. His act gave us a sense of connection with his world that we would never have had, and our commitment to live in harmony with that world has been strengthened. We will always carry with us the vivid image of the wolf at the window" (Hawkins 1988). The dying wolf may have sensed that the Hawkinses were friends of wildlife, having seen them put out food and watch him without taking any aggressive action toward him. Because he was a highly social animal who had been forced into solitude for most of his short life, he may have sought their company, sensing that he was close to death, preferring humans to an isolated and painful death without his pack mates. Whatever his motivation, his appeal to the Hawkinses' prior to dying was evidence of the complexity of this fascinating creature, and an indictment of the continued use of the inhumane steel jaw leghold trap.

Wolves, Wild Dogs and Foxes: Page 4

To counter the strong anti-wolf prejudice, a new organization called the International Wolf Center in Ely, Minnesota, has live wolves in an enclosure, museum exhibits and field classes. The 50,000 visitors it has received in the past few years brought $3 million to the local economy (Chadwick 1998). But wolves in Minnesota and elsewhere continue to be taken in traps set for other types of animals, causing injury or death. One study on wolves taken in various types of traps was published in the *Journal of Wildlife Management* (Ballenberghe 1984). It investigated injuries and mortality of 126 wolves trapped in northeastern Minnesota and Alaska. Traps used included steel jaw leghold traps of various types, some with teeth, others with smooth offset jaws; steel cable foot snares; and cable neck snares equipped with devices that prevented the loop from fully closing (Ballenberghe 1984). The results confirmed that steel jaw leghold traps caused the greatest number of injuries and mortalities: 41 percent of 109 adults, yearlings and pups caught in these traps incurred serious foot and leg injuries, defined as lacerations, damage to tissue, bone breakage, and joint dislocations (Ballenberghe 1984). Three wolves, including a pup, had broken leg bones; two others lost front feet after they were nearly amputated by the trap. One young male with broken radius and ulna bones in his foreleg was released in this study to stumble off; this wolf was caught by a trapper several months later (Ballenberghe 1984).

Other injuries resulted when trapped animals gnawed their own feet off and chewed on the traps, breaking teeth and

splitting lips. The steel jaw leghold traps caused tissue, muscle and tendon injuries, even when checked daily (Ballenberghe 1984). Since the observations carried out were not done by a veterinarian, or with aid of X-rays and other sophisticated tools to arrive at diagnoses, many unnoticed or undetectable damage to nerves, ligaments and other body parts almost certainly went undetected. Other effects of trapping noted in his study were heat and water stress; stress from risk of discovery and killing by people happening upon them; killing by other predators finding them trapped; and undiagnosed trauma (Ballenberghe 1984). In the same study, a wolf was killed by a cable neck snare when it passed over his chest and closed around his stomach. Long-term effects from broken teeth, severed tendons and poorly healed bones made survival unlikely. This was the case with Wolf 6530, described above, who suffered for many months with an injured paw after pulling free from a leghold trap, becoming weaker and weaker until he died.

Another method tested involved darting animals with tranquilizers from helicopters, which resulted in the euthanizing of a wolf after it became paralyzed when the dart penetrated its spinal column (Ballenberghe 1984). Of the animals darted, 85 percent sustained injuries and soft tissue damage. The Ballenberghe study also cited other research projects with even higher mortalities, and commented, "None of the wolf capture methods discussed here resulted in study animals that were free of injuries, but some methods clearly had more potential to inflict serious injuries than others."

The steel jaw leghold traps that Ballenberghe found to be the most injurious are the very traps that are still used by the Fish and Wildlife Service, Animal Damage Control (ADC)*, state game departments and others, killing wolves and many non-target animals. The US Department of Agriculture's Animal Damage Control program, which traps hundreds of thousands of Coyotes, Cougars and other predators for the benefit of livestock owners, has been responsible for the incidental trapping of endangered and threatened species, from Bald Eagles (*Haliaeetus leucocephalus*) to Gray Wolves.

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*Animal Damage Control (ADC) has since been changed to fiWildlife Services.fl

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Many wolves are trapped by wire snares. A loop of wire pulls tight and cuts through the skin when the animal steps into it or, in the case of a neck snare, it is placed a few feet off the ground and strangles and cuts through the flesh of an animal blundering into it. Most US states allow wire snares, and wolves are taken in them in Alaska. The Alaska Department of Fish and Game has sponsored various control programs or "studies" on wolves, using airplanes, steel jaw leghold traps and, most often, wire snares. The avowed purpose of recent state research, which involved trapping wolves in a large wildlife management area near Fairbanks, was to determine their population and effect on ungulate prey, such as Moose, Caribou and Elk. In fact, this and similar "studies" have been launched after hunters urged the state to eliminate wolves in order to leave more prey species. The rationale of the trapping program is based on the premise that killing wolves will result in increases in the population of these prey animals. A program in the 1970s involved the elimination of wolves from a 3,000-square-mile area, but according to Warren Ballard, a retired game biologist from Alaska, the Moose population did not rebound after wolves were exterminated (Egan 1992). Moreover, it creates an imbalance in the ecosystem. Killing of ungulates by human hunters does not cull the sick and old, but rather the fittest and largest.

In 1992, such a wolf "research" program, involving the setting of thousands of wire snares, was carried out south of Fairbanks. Gordon Haber, a conservationist and wolf biologist who has worked for decades on behalf of Alaska's wolves, brought television crews to film the snaring operation in December 1994. They were shocked by the scene that awaited them. Four wolves had been caught in wire snares, two of them pups. One was dead, and three were still alive, terrified and in great pain. A 6-month-old pup, with its paw caught in a neck snare, had chewed off its foreleg in a futile effort to escape. Another had been snared around the chest, causing deep wounds. The other two had been snared by the leg. All these snares had been set to catch the wolves by the neck and kill them, yet none did. Members of the pack milled about nearby, unwilling to leave their fellows. Two snared Caribou were lying dead nearby. A trapper was filmed as he attempted to shoot the wolves, repeatedly missing or wounding them because he used the wrong caliber ammunition in his gun. He shot one pup five times in the head and body at point-blank range with the

wrong gauge ammunition. The pup, wounded, remained standing. The trapper then reloaded with other ammunition, and this time shot all three wolves fatally.

The film of this massacre was shown on national news programs, causing outrage around the country. Alaska Governor Tony Knowles called off the hunt, ordered a review and stated, "That's no way to treat an animal." Six hundred and eighty-five snares set for this program were removed from state lands, but not before 12 more wolves had been killed. More than 1,000 snares had been set by the state for this "study," which lasted two years. On February 2, 1995, Governor Knowles made public the results of the Gray Wolf kill review. During the program, 134 wolves were snared, 37 of which were found alive and had to be shot. Also caught in the neck snares were Moose, Caribou, Grizzly Bears, Wolverines, Coyotes, Red Foxes, Arctic Hares, Common Ravens and Golden Eagles (AWI 1995). This gruesome haul of non-target animals is typical of the indiscriminate nature of snares.

Governor Knowles canceled the wolf kill indefinitely and ordered a review of Alaska's entire predator-control policy. This "research" program was permanently canceled in February 1995. A biologist with the Alaska Department of Fish and Game admitted in 1997, while appraising the program, that it had been ill-conceived, poorly run and politically motivated. He insisted, however, that wolves had suffered no pain from the snaring and even from chewing off their own paws. This failure to acknowledge proven neurological effects of such injuries is not unusual among state game department officials.

In 1996, the Alaska Department of Fish and Game began a new program to curtail the wolf population in the Fortymile region near Fairbanks. This time, the program consisted of sterilizing the alpha male and female of each of the 15 wolf packs in the area, with plans to relocate all "subordinate" wolves (Trost 1998). The plan to reduce all 15 packs to a single sterile pair was intended to increase the number of Caribou for hunters (Trost 1998). The Alaska Wildlife Alliance strongly opposed this project, and Gordon Haber expressed the opinion that it would reduce the wolves of the area to the brink of extinction (Trost 1998). This research program was described as "based on assumptions" by the National Academy of Sciences.

Alaska's trapping regulations are the laxest in the country, with no visitation requirement, meaning that trappers are not required, as in most states, to check traps daily for animals. Animals suffer in steel jaw leghold traps or snares for days. One case is known of a trapped Lynx--brought food by its mate--that lived for six weeks with its leg caught in a leghold trap.

No state regulations govern the manner in which trapped animals are killed, and trappers often stomp trapped animals to death to obtain pelts without damage--such as that caused by bullet holes--to the pelt. The Alaska Game Department takes advantage of the strong ties between wolf pack mates by requiring trappers of wolves to count the number of wolves in the packs of the animals they trap. Pack mates will usually remain by their trapped pack mate, even when it is dead in a trap.

Wolves, Wild Dogs and Foxes: Page 5

Aerial hunting of wolves was carried out for decades in Alaska by private parties and the Alaska Department of Fish and Game itself. Prior to 1972, wolves could be hunted from airplanes for sport, or by state predator-control agents. Federal legislation was enacted in that year to ban such hunting, with high penalties including confiscation of aircraft, large fines and even jail terms. In fact, Director of Wildlife Conservation David Kelleyhouse, known as "Machine Gun Kelleyhouse," suggested that the best way to control wolves was to machine-gun them. In 1991, a state law was passed in Alaska that allowed shooting of wolves if the aircraft landed 330 feet away from the animals. This legislation was virtually impossible to enforce. Many hunters flew over wolf packs, hazing them until the wolves were too exhausted to escape. Then they would land and kill the wolves. The law failed to protect wolves from this type of

harassment and killing. Among the misuses alleged were trappers checking their trap lines by flying from one set to another, and killing wolves and other predators they saw. Another common practice that was targeted was the "recreational" aerial hunting of wolves. Conservationists in Alaska began a petition campaign to change the law through voter ballot referendum for the November 1996 national election, having failed to persuade the legislature to enact a stricter law. This ballot was openly opposed by many members of the Alaska Department of Fish and Game, who were then chastised for this lobbying by the Governor. The ballot was voted into law by the Alaskan public. The new law states that no one who flies an aircraft to an area and lands, may shoot a Gray Wolf, fox, Lynx or Wolverine on the ground the same day. This closed the loophole left by the previous law.

Wolf hunting is carried out by snowmobilers in many parts of Alaska. Brenda Peterson, an eyewitness to one of these hunts, described it, and photos taken of the event documented the wolves being chased into a tight group and killed (McIntyre 1995). Six black wolves, an entire family, died "splayfooted against one another," having run for their lives at a gallop of 35 miles per hour as the snowmobilers herded them into a terrified, dense mass, and then shot them at point-blank range (McIntyre 1995).

The total kill of wolves by hunters and trappers in Alaska in recent years has declined from 1,600 taken in the winter 1993 to 1994 to 1,180 taken in 1995 to 1996, according to the Alaska Department of Fish and Game. With a total wolf population in the state in late 1995 estimated at about 7,000, the kill represents 17 percent of the total population. This is probably threatening some populations. One race of Alaskan wolves, the Alexander Archipelago Wolf (*Canis lupus ligoni*), an extremely rare subspecies, resides in the heavily logged Tongass National Forest. In spite of various threats, the US Department of the Interior has refused to list the wolf on the US Endangered Species Act (see Forests chapter).

Within the past few decades, wolves have again become resident in several western states. Beginning in the 1970s, a few Gray Wolves crossed the border from Canada into Montana's Glacier National Park where a population of about 100 wolves in 10 packs now lives (Stevens 1997).

Wolves, Wild Dogs and Foxes: Page 6

In the 1990s, the Fish and Wildlife Service began a reintroduction program of wolves into Yellowstone National Park and portions of Idaho and Montana to the north. Historically, wolves were killed to the last individual in Yellowstone National Park by park service personnel under predator-control laws. Their return is a vindication of their importance in the ecosystem. From the start, the project was fraught with difficulties and controversy, with conservationists pitted against one another as to methods and regulations, and many cattle and sheep ranchers opposing the entire project, vowing to kill any wolves that strayed out of the park. Defenders of Wildlife began a fund to repay ranchers for lost livestock, which helped convince some ranchers to accept the project. Of the 14 Canadian wolves released in 1995 in Yellowstone National Park, almost all remained within the park. Two packs produced a total of nine pups, and 17 more wolves from Canada were set free in the park in 1996. The largest of the reintroduced wolves and his mate left the park, and he was gunned down by a drunken man for sport; he skinned this big male and threw the carcass into the brush. Later, the wolf's pregnant mate found the skinless carcass and dug a den beside it. The hunter who, in defiance, sported a shirt reading "Northern Rockies Wolf Reduction Project," spent six months in jail and a year of supervised probation after being found guilty of deliberately killing the wolf.

These Canadian wolves, taken from areas where they were hunted and trapped, experienced a trap- and gun-free environment in Yellowstone National Park. They have adapted well, preying mainly on Elk, which had become overpopulated. Only a few Bison have been taken. Within a few years, the wolves have had major effects on the park's ecosystem. Grizzly Bears have benefited by feeding off the remains of wolf kills, as have ravens, foxes, Bald Eagles and Golden Eagles. The park's aspen trees have also benefited. Researchers from Oregon State University determined

that until the late 1920s, young aspens were able to survive and mature within existing groves, but after the last wolves were killed off about 1926, the aspens began to die out because the overpopulated Elk browsed on these trees in the winter, stunting them. Another change that resulted from the absence of wolves was the disappearance of smaller birds, such as the Calliope Hummingbird (*Stellula calliope*) and Willow Flycatcher (*Empidonax traillii*), from brushy areas that were heavily browsed by the large populations of Elk and other ungulates. Wildlife Conservation Society (WCS) biologists have been researching the many effects of the return of wolves on the park's ecology (WCS 2000).

By 1996, three packs of wolves occupied the park, and a fourth pack of four wolves lived on the park's northwestern border. Their total population in Yellowstone has risen to about 185, exceeding the expectations of scientists (Murphy 2000). Although detractors remain, wolves have garnered a great deal of support. Scientists have come to Yellowstone National Park to study the wolves, some saying it is the best place in the world to see these animals in an open habitat, exhibiting natural behavior. Tourists, likewise, have flocked to see the Yellowstone wolves, bringing $43 million a year to the area, according to Defenders of Wildlife (Rembert and Motavalli 1998). Visitors have been thrilled to see these wolves streak across the grasslands, meet in affectionate, playful groups and raise their melodious voices in group howls. The wolves are expected to be a major tourist attraction in the future, perhaps rivaling the world-renowned geysers. Television films have been made of the wolves, chronicling their reintroduction and pack behavior, and *The Return of the Wolf to Yellowstone*, a book by Thomas McNamee (1997), recounts their reintroduction.

The wolves were released under a special designation of the US Endangered Species Act known as "non-essential, experimental populations," a category that permits authorities to kill them if they are found preying on livestock, or even if they cause adverse effects on wild ungulates such as deer and Elk. It is not legal to kill them for sport deliberately (FWS 1994). As a result, many wolves straying outside Yellowstone National Park have not fared well. One pack of 13 that roamed the plateaus north of the park declined to a single wolf in one year; all but three, who are now back in captivity, died or were shot (Murphy 2000). Several conservation organizations sued the Fish and Wildlife Service to appeal the non-essential designation, stating that there were already some wolves present that would be killed at will because of the designation. Livestock owners also sued the government, requesting that the program be stopped and the wolves be removed. These lawsuits were not heard in federal court until late 1997, after 66 wolves had been brought from Canada to Yellowstone and Idaho in 1995 and 1996.

In December 1997, the lawsuits from both sides of the wolf issue were finally heard in a US District Court, which came to the stunning decision that the Fish and Wildlife Service had violated the US Endangered Species Act by declaring the wolves an experimental population because wolves that might already be present would be denied full protection of the law. The judge ordered that the reintroduced wolves be removed from the park, but stayed his own decision pending appeal. Secretary of the Interior Bruce Babbitt expressed the Department's support for keeping the wolves in the wild. The Fish and Wildlife Service stated that should the decision be upheld on appeal, the wolves would have to be euthanized, as there was no area where they could be released (Chadwick 1998). The decision was appealed and overturned in January 2000, allowing the wolves to remain as part of Yellowstone's ecosystem for the indefinite future.

For the long-term success of the reintroduction of Gray Wolves into this region, the entire Yellowstone ecosystem, which extends well beyond the limits of the national park and other federal lands, should be protected. Already, much prime habitat that was once occupied by wildlife has been converted for agriculture, livestock and homes. Growth of housing and spread of the urban landscape in Jackson, Wyoming, are gobbling up thousands of acres each year. At least one cattle ranch has recently been purchased as a buffer for wolves and bison straying out of Yellowstone National Park. Efforts should be made to acquire more habitat so Yellowstone's wolves and those to the north could be linked through forest corridors to avoid inbreeding and provide space for expanding populations. The Greater Yellowstone Coalition has proposed a program called Y to Y, or Yellowstone to Yukon, that seeks an even more ambitious goal: to link reserves and parks between the two areas, providing a vast wildlife corridor. Much of the land in this linkage area is already federally owned. Grizzly Bears and wolves are among the many wildlife species that

require enormous amounts of habitat, and unless action is taken now, populations of these and other wide-ranging animals will become isolated and inbred.

Central Idaho has 12 million acres of national forest land and was chosen as a release site because of the enormous potential habitat. Opposition to the reintroduction in Idaho was strong, and the state legislature blocked the involvement of the state wildlife department (Robbins 1997). The Nez Perce tribe, which has a strong commitment to preserving the wolf, stepped into the void and became the first Indian tribe to manage an endangered species in an entire state (Robbins 1997). The project is headed by a tribal leader, Jaime Pinkham, a forest biologist who returned to his tribal roots and became manager of the Nez Perce Department of Natural Resources (Robbins 1997). Conservation groups, such as the Gray Wolf Education and Research Center in Idaho, are attempting to change the anti-wolf opinions of local ranchers with films, several penned wolves and other programs. Unfortunately, wolves have been released in Idaho and in Montana, where many have been shot, trapped or died from other causes. They lack the protection of a large national park where hunting and trapping are prohibited, and many ranchers graze cows and sheep in and near the national forests.

Most wolves prefer wild prey, but because of the large number of livestock in the region, the success of these releases may depend on whether the wolves can be conditioned to keep away from livestock. Several of the reintroduced wolves have killed calves in Idaho and Montana, resulting in anger from ranchers who have convinced the Governors and many state delegates to legislate against the program. Fears have even become irrational. Some ranch mothers sent letters to Idaho's Congressional delegation demanding that children be guarded from wolf attacks at school bus stops (Corbett 2000). The Republican delegation from Idaho passed a unanimous resolution at their convention, calling for the immediate removal of all reintroduced wolves (Corbett 2000). Signs urging that wolves be killed were placed in store windows in Idaho. Fish and Wildlife Service biologists killed 82 wolves during the first five years of the program, after complaints from livestock owners (Corbett 2000). Several wolves were shot under questionable circumstances. After a calf was killed, for example, the Service ordered three adult males of the pack killed from a helicopter; sharpshooters, unable to kill the adults, ended up shooting three pups (Murphy 2000). After ranchers reported that a pack had backed a group of his horses against a cliff, the alpha male was removed, leaving his mate alone and the pack without a leader (Murphy 2000).

Some environmentalists protested these killings and threatened to interfere before more wolves were shot (Corbett 2000). David Gaillard of the Predator Conservation Alliance questioned the wisdom or purpose of introducing wolves that needed to be controlled and trained (Murphy 2000). Experiments are underway using electric shock collars that shock a wolf when it comes close to a cow or calf wearing a collar that sets it off. This is a crude approach, which inflicts pain on the wolves and may not even succeed in its intent. Some humane organizations that have protested these collars have rightly stated that almost no efforts have been made to teach ranchers to protect their livestock with sheepherding dogs, pen them in at night and before calving and lambing, and use other means of preventing predation.

Wolves, Wild Dogs and Foxes: Page 7

Historically, the critically endangered Mexican Gray Wolves (*Canis lupus baileyi*) roamed montane woodlands and drylands in northwestern Mexico and extreme southern Arizona, New Mexico and Texas. After centuries of persecution, they disappeared altogether from the United States and verged on extinction in Mexico. In 1976, the subspecies was listed on the US Endangered Species Act, and in 1982, the Fish and Wildlife Service approved a recovery plan in which a professional trapper was hired to capture the last few wild wolves in Mexico. Only five of these wolves were found, and in this 11th-hour rescue, they were live-trapped in Chihuahua and Durango for captive breeding (Brown 1995). They have bred well in captivity and, in 1998, numbered 175 distributed in a number of American zoos (Bass 1998). Through genetic testing, new strains of pure Mexican Wolves have been identified in

Mexican Wolves already in captivity; this adds to the subspecies™ known diversity (Brown 1995). Smaller than northern wolves, males weigh 60 to 70 pounds and females 50 to 60 pounds.

The recovery plan's major goal was to reintroduce Mexican Gray Wolves into portions of their original range in a joint project by the Fish and Wildlife Service, the ADC program which had been responsible for their demise, the US Army, and the state wildlife departments of Arizona and New Mexico (Brown 1995). Surveys conducted in the region determined that most people favored the reintroductions (Brown 1995). Ted Turner, the founder of Cable News Network (CNN) and other cable stations, is New Mexico's largest landowner with more than 1 million acres. He offered one of his ranches, Ladder Ranch, which is near the Blue Range mountains release site, as a holding area and paid an employee to oversee construction of holding pens (Bass 1998). This was supported by his organization, the Turner Endangered Species Fund (Bass 1998).

Although the public as a whole supported the wolf reintroduction, many New Mexican ranchers expressed great antipathy. The national forest release sites allow hunting and trapping. Many volunteers and a grassroots organization, Preserve Arizona's Wolves (PAWS), have worked for decades to bring about this reintroduction and volunteered their time to help on Ted Turner's ranch preparing for the arrival of wolves from two zoos (Bass 1998). In December 1997, four wolves, two sisters and two brothers from separate zoos, arrived at Turner's ranch and were paired off male-and-female in separate pens, where they stayed for several months (Bass 1998). More arrived and spent time in acclimatization pens before release. The release program failed. Of 11 Mexican wolves released in the area, five died, one disappeared and is presumed dead, and five have been returned to captivity near Alpine, Arizona (Sink 1998). One pup born in the wild is missing and presumed dead, since its mother was shot in August 1998 (Sink 1998). A New Mexican rancher is said to have offered $35,000 to anyone who would kill all the wolves returned to the wild (Sink 1998).

Among the wolves that were shot was one of a newly formed--but strongly bonded--pair, Val and Minnie (Bodo 1999). Soon after release from the holding cage, Val was shot by a camper who claimed that the wolf charged at him; a necropsy revealed that the wolf had been killed standing still, broadside to the man (Bodo 1999). The female, Minnie, who had been born at the Rio Grande Zoo in Albuquerque, was pregnant with four pups when her mate was killed. She was returned to her holding pen and began to try frantically to dig and leap her way out of the pen (Bodo 1999). Her pups were born, but all died. At the end of 1998, she was shipped to the Living Desert Wildlife and Botanical Park in Palm Desert, California, where she paced or remained curled up in a spot of dirt, failing to interact with her surroundings or a male put in her pen (Bodo 1999). She was spayed and will remain in captivity for the rest of her life. As for the other deaths, no examples of livestock predation were found. About 140 of these wolves remain in captivity (Nowak 1999).

The reintroduction of Mexican Gray Wolves will be far more difficult than the Yellowstone National Park reintroduction, which involved transplant of wild Canadian wolves. These captive-born wolves have no knowledge of wild survival. They will need to learn how to hunt large prey as a pack, as well as how to survive the many threats humans pose to them. Their intelligence and instincts may be the deciding factors for their survival.

The legal status of the Gray Wolf in the lower 48 states seems destined to change in the near future. The Fish and Wildlife Service wants to change the status of the species from Endangered to Threatened in all but the southwest, where the Mexican subspecies is being reintroduced, and remove the Minnesota wolves altogether from the US Endangered Species Act (Revkin 2000). Minnesota wolves continue to be persecuted, and suffer from parasitic heartworms and deadly canine parovirus disease spread by domestic dogs (Nowak 1999). Delisting undoubtedly will unleash unrestricted hunting and trapping of these animals. Total legal control will revert to the state of Minnesota should this proposal be finalized.

The wolves in the West, from Yellowstone National Park to Idaho, Montana and Washington, would be listed as Threatened when removed from the experimental category. This category has much more flexibility concerning how much protection a species receives. Penalties are lower, and species may be hunted and trapped under the category.

Some ranchers in the West are prepared to eliminate wolves outside national parks. One rancher in Montana installed loud alarms that are triggered by the radio collars used to monitor most of the area's wolf packs (Revkin 2000).

The approximately 3,500 wolves south of Alaska, most of which are in Minnesota, occupy only about 5 percent of their original range, and as a result of prejudice and unfounded fear, these wolves are still being persecuted. Several states have enacted laws banning reintroduction of wolves, which would also apply to wolves crossing over the state's borders. Proposals to reintroduce wolves into Maine or New York have also been met with opposition by many (Higgins 2000). A major education program is needed to allay these fears and to train ranchers to protect their herds and flocks, compensating them for any losses. Although the detractors speak more loudly than the defenders of wolves, the latter probably far outnumber the former in the United States as a whole. It may fall to private conservation and humane organizations to turn the tide in favor of the wolves to return them to a greater percentage of their original range in the lower 48 states.

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Elsewhere, the history of the Gray Wolf is similar. As early as 300 B.C., Celtic people in the British Isles began breeding wolfhounds for chasing and killing wolves (McIntyre 1995). The King of Scots decreed in the second century B.C. that anyone killing a wolf would be rewarded with an ox (McIntyre 1995). In Anglo-Saxon England, January was designated Wolf Month, to be devoted to the slaughter of wolves; during the reign of King Edgar of England, beginning in 953, a tribute of 300 wolf skins per year was demanded. In 1281, King Edward I hired a man to devote himself entirely to killing wolves (McIntyre 1995). Over the next centuries, wolf extermination campaigns continued in the British Isles, and forests were leveled for livestock grazing and agriculture. The last wolf in Ireland was killed in 1821, and a wolf killed in Scotland in 1848 resulted in the extinction of the species throughout the British Isles (McIntyre 1995).

In France, Emperor Charlemagne founded an order of knights for killing wolves, called the Louveterie, about A.D. 800 (McIntyre 1995). Wolves were exterminated 1,000 years ago in all but remote forests of the French Pyrenees on the border with Spain. By the 20th century, only a handful of Gray Wolves survived in these forests, and apparently they were killed off in the 1950s. In the early 1990s, small numbers of Gray Wolves crossed over the Alps from Italy into southeastern France. In 1999, the French government decided to remove these 40 wolves, killing or caging them, after complaints by herdsmen that the wolves were killing sheep (Newman 1999). Environmentalists claimed the sheep were being killed by feral dogs (Newman 1999).

The last wolf in what is now Germany was killed in 1847 (McIntyre 1995). Within the past decade, a few wolves have entered eastern Germany from Poland, which has a population of about 1,000 wolves (McNamee 1997). Polish wolves have been heavily persecuted for centuries, and only in 1998 did the species receive official protection (Nowak and Myslajek 1999). They occur mainly in eastern mountains where they have come into conflict with livestock owners. An organization, Wolfnet, has been working with livestock owners to compensate them for losses and protect them against predation by wolves (Nowak and Myslajek 1999). Wolfnet travels around the country educating the public, government officials and students about the behavior, biology and intelligence of wolves, attempting to undo the mistaken beliefs that result in many killings of wolves (Nowak and Myslajek 1999).

Scandinavia has nearly wiped out its wolves, with only about 25 in Norway and Sweden and fewer than 100 in Finland (McNamee 1997). In 2001, the Norwegian government allowed the killing of some of the few remaining wolves because of complaints by livestock owners, despite protests from wildlife organizations in the country. An unknown--but small--number also survive in Greenland (McNamee 1997).

In Spain, wolves may total from 1,500 to 2,000, the largest population in Western Europe (McNamee 1997, Binder

2000). They are heavily persecuted there, however. At one time wolves were found throughout the Iberian peninsula, but they are now confined to the northern portions of Spain and Portugal (Bergman 1997). In Portugal, only about 150 survive. The wolves of Spain and Portugal are listed by the *2000 IUCN Red List of Threatened Species* as Conservation Dependent. At least half of rural people in areas where wolves remain in Iberia believe the animals should be exterminated altogether, while another 35 percent want them "controlled," allowing only a few to survive (Bergman 1997). Wolves may be sport hunted in Spain, resulting in the deaths of at least 300 animals a year; added to this mortality, the practice of denning, or killing pups in a den, is legal, and 25 percent of wolves are killed in this manner (Bergman 1997). Luis Mariano Barrientos, a biologist studying Spain's wolves, has documented that they kill relatively few sheep, which are usually protected by mastiff dogs and shepherds. He says that the wolves are killed because of prejudice and persecution, and laments, "It's a national disgrace. A barbarity" (Bergman 1997). A recent study recommended that a strict compensation program be set up. At present, indemnities are paid only if local administrations choose to do so, and many do not (Bergman 1997). This results in great resentment toward wolves. The wolves of Spain survive by stealth, hiding in fallow fields and moving about at night, and when they howl, they risk their lives (Bergman 1997). For long-term survival in Spain, they need a large sanctuary with natural prey species.

Small populations of Gray Wolves still remain in pockets of the Mediterranean region. About 500 wolves survive in Italy, listed as Vulnerable by the International Union for the Conservation of Nature (IUCN). Very little wilderness remains in the country, and wolves have been squeezed into agricultural and livestock grazing areas (McNamee 1997). Their survival until the 20th century is due to an attitude of tolerance, unlike the prejudice and hatred toward wolves so common in Europe. No national extermination campaign was ever launched, and herders corral their sheep at night and protect their flocks with guard dogs (McNamee 1997). Because of a lack of natural prey, such as deer, in the region, these wolves occasionally kill livestock. When this happens, herders put out poison or shoot the wolves. Italian wolves live in pairs or groups of three in most areas because there are no large ungulates to hunt in packs. This has made them quiet, nocturnal and shy. These wolves also prey on small mammals, such as rabbits and marmots (McNamee 1997). Only in a few national parks, such as the Abruzzi east of Rome where about 20 to 30 wolves hunt deer, do they exhibit natural behavior, forming packs and howling (McNamee 1997). Even there, however, sheep are allowed to graze within park boundaries, and sheep owners have been soliciting members of the public to "adopt" a sheep to contribute to the cooperative farm (Stanley 2000). By the 1970s, wolves numbered only a few hundred, but after the government accorded the species full protection in 1976, they began to increase in numbers and range (McNamee 1997). They now occupy the entire country, and if there are livestock losses, owners are compensated and are not allowed to kill the wolves (McNamee 1997). Professor Luigi Boitani, a wolf biologist at the University of Rome, commented at a wolf conference that most of the Italian public is in favor of wolves and more opposed to control programs than some wildlife managers, like himself (Binder 2000). The official protection given to these wolves is far stronger than that given to either the Gray or Red Wolf in the United States.

Southeastern Europe's wolf populations are fragmented, but increasing in some countries. The former Yugoslavia has about 930; Hungary, 50; Romania, which protects the species, 2,500; Bulgaria, fewer than 100; Slovakia, 350; and Greece, 300 to 500 (McNamee 1997). Romania is the only one of these countries where people have a tradition of honoring wolves; sheep in the country are protected by guard dogs, and wolves prey mainly on native ungulates. In some areas the wolves have taken to ranging through city trash piles for food (Binder 2000). Croatia allowed unlimited killing of wolves until 1995 when fines of up to $6,000 were imposed for killing wolves (Binder 2000). This had the counter-effect of encouraging wolf killing, resulting in the deaths of more than 40 wolves, and no one has paid a fine; about 100 wolves remain in the country (Binder 2000).

In the eastern Mediterranean, there are estimates of a few wolves remaining in Lebanon; about 30 in Egypt; 200 in Jordan; 150 to 300 in Israel; several thousand in Turkey; and about 1,000 in Iran (McNamee 1997). In Saudi Arabia, where wolves are killed to protect livestock, hunters often string up a wolf carcass on a pole for all to see (Binder 2000). Dr. Iyad A. Nader of the King Khalid Wildfire Research Center in Riyadh, estimated that up to 700 wolves remain in three protected areas of Saudi Arabia, but elsewhere in the country they have no legal protection (Binder 2000). Wolves are persecuted by livestock herders in all the latter countries.

Just after World War II, there were between 150,000 and 200,000 wolves in the Soviet Union, but beginning in 1947, an intensive government control program drastically reduced their numbers (Nowak 1999). The annual kill was 40,000 to 50,000 until 1962, when it dropped to 15,000; in the 1970s, some 50,000 wolves were estimated to survive in the entire country, including the Central Asian Republics (Nowak 1999). After an increase in wolf populations, a sizeable bounty was paid for killing them; and in 1980, 35,573 pelts were taken through aerial hunting, poisoning and other means (Nowak 1999). fiThe Russian Grey Wolffl (1993, Anderson Video, California) chronicled this bounty hunting and other persecution. In the past 70 years, more than 1.5 million animals have been killed; about 20,000 wolf pelts are marketed in Russia every year (Busch 1995). In the early 1990s, 17,000 men were employed by the Russian government to kill wolves. Since then, the national bounty has been rescinded, and only some state governments pay the equivalent of $25 for a female; the central government no longer encourages poisoning wolves (Binder 2000). In the Russian Far East, a bounty program to kill wolves has been in place for decades, but with the economic chaos following the fall of the Soviet Union, funds to pay the bounties dried up (Specter 1997). A 2001 Cable News Network (CNN) report profiled a government trapper who killed female wolves for the bounty, then raised the orphan cubs for release. The report suggested that persecution continued at high levels and that most Russians wanted the species exterminated.

The Wolf Almanac (Busch 1995) states that some 96 Russian wildlife reserves harbor wolves, and they are hunted actively in 41 of these. They are reported to be safest in certain large reserves, such as the Caucasian, Altai and Pechyora-Ilych reserves, unless they stray outside to prey on livestock (Busch 1995). Wrangel Island in the Arctic Ocean is to be made into a nature preserve with a wolf colony to cull the large herds of Musk Oxen and Caribou (Binder 2000).

Japan's wolves were killed off 100 years ago, and public opinion is negative about their reintroduction. Biologists want them reintroduced to control Japan's overpopulated Sika Deer, which are damaging forests (Binder 2000).

In Kazakhstan and Central Asia, wolves and Saiga antelope have coexisted for eons, but during this century, both have come under heavy hunting. A film, fiThe Saiga of Kazakhstanfl (see Video Section), describes the detrimental effect that wolf control programs have had on Saiga. Wolves are estimated to number between 90,000 and 100,000 in the country, but biologists claim that they kill large numbers of domestic camels, cows and sheep (Binder 2000). Killing wolves is considered a sport in Kyrgyzstan, south of Kazakhstan, where Golden Eagles are used as falconry birds to hunt foxes, badgers, Lynx and wolves (Kinzer 1999).

Mongolia has an estimated 10,000 wolves; China only about 400; and Afghanistan, 1,000 (McNamee 1997). In Tibet, wolves are heavily persecuted by livestock owners, and in the vast Chang Tang Reserve, it is the only species without legal protection. Wolf carcasses can be seen lying next to roads, the animals having been shot by hunters in vehicles, and biologist George Schaller (1998) saw three wolf bodies in a village dump with their jaws wired shut.

India has fewer than 1,000 wolves by some estimates (McNamee 1997), and between 800 and 2,000 in the opinion of Dr. Yadvendradev Jhala of the Wildlife Institute of India. The species is held in great fear by many Indian people, who regard wolves as man-eaters. A century ago, a bounty program resulted in the slaying of 2,600 wolves (Burns 1996). Indian Gray Wolves (*Canis lupus pallipes*) were finally accorded official protection in India in 1992. Rudyard Kipling's *The Jungle Book* tells the story of Mowgli, an Indian orphan raised by wolves. This story may have a basis in fact because many unwanted children are abandoned and placed in the woods, according to *The Wolf Almanac*, and Indian folklore recounts many cases of small children raised by wild wolves (Busch 1995). Such a child was discovered in 1972 at the age of four, apparently having been adopted by a pack of wolves. He was placed in Mother Theresa's refuge for orphans in Lucknow, where he died after seven years (Busch 1995). In spite of such true stories, the average Indian has little but fear and loathing for wolves.

Working to help India's wolves, Dr. Jhala and the Wildlife Institute of India are conducting surveys and appraising their status. For centuries, these wolves have lost habitat and prey species to the country's growing human population. When wolves turned to livestock, persecution followed. Dr. Jhala admits, "It is extremely difficult to conserve a

species when the majority of the human population is opposed to its survival" (*Earthwatch* 1996). Beginning in 1988, Dr. Jhala conducted the first-ever ecological study of Indian wolves for his doctorate at Virginia Polytechnic Institute, with funding from the National Geographic Society and the Smithsonian Institution (*Earthwatch*, 1996). Earthwatch contributed to this research in 1996 with its volunteer program of paying participants in Dr. Jhala's studies. These volunteers followed radio-tracked wolves in the 3,400-hectare (8,401-acre) Velavadar National Park of western India, one of the wolf's last strongholds, observed Blackbuck (*Antilope cervicapra*), Nilgai (*Boselaphus tragocamelus*) and other rare wildlife, and interviewed local farmers through interpreters about their opinions of this species.

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Official protection from hunting and trapping has been accorded very few wolf populations in the world, even where they are on the verge of extinction. In some areas, however, attitudes are changing, most dramatically in the United States, where documentary films and books on their behavior and importance in ecosystems, as well as recordings of their howls can now be seen in bookstores throughout the country. Superb photography illustrates some of these, most notably *White Wolf: Living with an Arctic Legend* (Brandenburg 1992), which provides glimpses into the lives of these fascinating canids in the Canadian north. Reintroductions of wolves into portions of their former range in the American West bode well for their future, unless the prejudices of many livestock ranchers hold sway. Canada may have the largest population of wolves in the world, estimated at between 30,000 and 60,000, with about 4,000 killed for fur each year (Nowak 1999). According to genetic studies, the wolves of southern Ontario and southern Quebec have apparently hybridized with Coyotes, as have wolves in neighboring Minnesota and Isle Royale, Michigan (Nowak 1999).

The ecotourism potential for wolf viewing in many parts of the world is considerable. In Ontario, Canada, visitors to Algonquin Provincial Park have come to hear packs howl since the 1960s. One of the first wolf conservationists, Canadian wolf biologist Dr. Douglas Pimlott, initiated these tours and educated thousands of people about the biology, importance to ecosystems and behavior of wolves. Their value in attracting tourists and contributing to healthy ecosystems far exceeds that of their pelts.

For some other species of wild dogs, attitude changes may not be enough to save them. The Dhole or Asiatic Wild Dog (*Cuon alpinus*), a small canid the size of a Coyote, is native to Asia, from southern Siberia and Central Asia east to India and Indonesia (Nowak 1999). This wild dog has rusty red fur on its upper parts, and white on its chest and belly. Hunting in large packs, Dholes pursue large prey, such as deer, wild pigs, antelope and wild sheep (Nowak 1999). Their social structure is not well known but appears similar to the Gray Wolf's, with a leader and lower-ranking members of the pack (Nowak 1999). Although Dholes seldom take livestock, they have been poisoned intensively and hunted throughout their range; they are also persecuted by hunters who regard them as competitors for game species (Nowak 1999). Dholes have disappeared from much of their habitat, and the *2000 IUCN Red List of Threatened Species* lists the species as Vulnerable, the category below Endangered, indicating a serious decline.

Similar in appearance, the Simien or Ethiopian Wolf (*Canis simensis*) is endemic to Ethiopia. Scientists were unsure in the past whether this animal was a dog, a wolf, a jackal or a fox. Most zoologists now describe it as a wolf. It may be related to the small race of Gray Wolf, *Canis lupus arabs*, that inhabits the Arabian Peninsula across the Red Sea (Nowak 1999). Simien Wolves have a head and body length of about 3 feet, are about 2 feet tall at the shoulder, and weigh from 11 to 19 kilograms (Nowak 1999).

The only wolf not preying on animals larger than itself, such as deer, but living in packs, Ethiopian Wolves feed mainly on small rodents (Gottelli and Sillero-Zubiri 1994). Once their range was far greater, encompassing most of Ethiopia's highlands, but with the development of agriculture and spread of livestock grazing, these wolves lost the majority of their habitat and came under totally unmerited persecution as a threat to domestic animals (Nowak 1999).

Today, they have become restricted to only about six locations in the Ethiopian highlands. Discovered in the Simien Mountains of the northwest, the subspecies, *Canis simensis simensis*, was estimated at only about 40 animals in the 1980s. These wolves are so shy that even in the Simien Mountains National Park they have become nocturnal and stay in burrows when humans are in the vicinity. A crew from Survival Anglia, a British nature film company, spent weeks in the early 1990s seeking to photograph the Simien Wolves in this park, finally having to settle for a long-distance view of a solitary wolf.

Wolves of the Bale Mountains, separated by hundreds of miles, are larger and redder than the Simien Mountains race, and this subspecies, *Canis simensis citernii*, is somewhat more numerous than the other race. Only about 440 Simien Wolves were thought to survive in the Bale Mountains in the early 1990s, with perhaps another 100 in the Simien Mountains (Gottelli and Sillero-Zubiri 1994). Today, estimates are even lower. The Bale Mountains population is estimated at 270 to 370 animals, and 70 to 150 survive in the Simien Mountains (Nowak 1999). This species is thus at the edge of extinction. It is listed as Critical in the *2000 IUCN Red List of Threatened Species*, protected by law in Ethiopia and listed as Endangered on the US Endangered Species Act.

The Wildlife Conservation Society (formerly the New York Zoological Society) has funded research projects on the Simien Wolf for many years, including the studies of two zoologists, Dada Gottelli and Claudio Sillero-Zubiri in Bale National Park. Simien Wolves use their long legs to dig into rodent tunnels, aided by their acute senses of hearing and smell. In Bale Mountains National Park, 14 rodent species are native and three dominant species are endemic to the region, providing a huge food base for the wolves. They specialize in preying on the endemic Ethiopian Mole Rat (*Tachyoryctes macrocephalus*). The mazes of tunnels that these rats excavate aerate the soil, creating rich topsoil which nourishes the lush grasses in this highland ecosystem. The wolves have been seen hunting cooperatively, chasing young antelope and hares (Nowak 1999).

Livestock grazing is allowed in Bale Mountains National Park, and Simien Wolves wander among the cattle, presenting no threat. The wolves in this park have not been persecuted, unlike those elsewhere in Ethiopia, and do not hide from people. Filmmakers shooting the 1990 BBC film, fiKing Solomon's Mountains,fl found the wolves in the open during the day, with adults hunting rodents, and pups playing wrestling games. Like other wolves, they are extremely affectionate with one another and yip in group choruses, sounding like Coyotes. Packs range in size from five to 13 animals, and they defend territories. As in Gray Wolf packs, only one female in the pack breeds, and because of limited habitat, nonbreeding females often stay with the pack, acting as "aunts" instead of leaving to begin their own packs (Gottelli and Sillero-Zubiri 1994).

Domestic dogs, brought into Bale Mountains National Park by the Oromo people to protect their flocks of sheep and cattle from hyenas, are a major threat to this species (Gottelli and Sillero-Zubiri 1994). Wolves have succumbed to diseases introduced by these dogs, which are not fed but set free to fend for themselves. Between 1992 and 1995, the Bale Mountains wolves were decimated by an outbreak of canine distemper acquired from these dogs, reducing the wolves from 240 to 140 (Anon. 1996). In the mid-1990s, more died of rabies. An even more ominous threat is their interbreeding with domestic dogs. The film fiKing Solomon's Mountainsfl showed a pack of wild Simien Wolves led by a large black dog that had become the lead female. Another film, fiLast Wolves of Ethiopia,fl shown on a National Geographic Explorer program in early 1998, recounted the story of a young female Simien Wolf who was ousted from her pack and, after a few years of wandering, paired with a hybrid wolf-dog. In general, male domestic dogs have bred with female wolves, diluting the genetic integrity of this highly endangered animal (Gottelli and Sillero-Zubiri 1994). Some populations of pure Simien Wolves are showing signs of inbreeding, due to their small genetic base. The combination of these threats has led scientists to predict imminent extinction for this beautiful wild dog.

To prevent their extinction, attempts are being made to convince the Oromo tribespeople to control their dogs, but scientists have concluded that captive-breeding may be the only way to save the species (Gottelli and Sillero-Zubiri 1994). There is no possibility of preventing these people from entering the park because of the tribe's centuries-old ties with this region and the potential of bad relations with them that could have serious repercussions on the conservation of park wildlife (Gottelli and Sillero-Zubiri 1994). As a means of controlling the domestic dogs, they could be

neutered, vaccinated against disease, and provided supplemental food to prevent their attacking native ungulates in the park. A vaccination program has recently been carried out in the Serengeti, where domestic dogs transmitted canine distemper that killed one-third of the Lions in the region.

The South American Maned Wolf (*Chrysocyon brachyurus*) has also declined, although not as drastically as the Ethiopian Wolf. This long-legged wolf, weighing only about 44 pounds, hunts in the tall grasses of pampas and llanos, and eats rodents and other small mammals, birds, reptiles, insects, fruit and other vegetation (Nowak 1999). With shaggy red fur and black legs, it has been called a Red Fox on stilts. It is the sole member of its genus and the only wolf in Latin America. The Falkland Island Wolf (*Dusicyon australis*), native to the Falkland Islands off Argentina, became extinct in 1876 after large numbers were killed by fur traders and poisoned by sheep ranchers (Allen 1942). The size of a large Coyote, it may have evolved from foxes. Maned Wolves have been falsely accused of killing livestock, and persecution has caused them to disappear from Uruguay and most of Argentina. They have become rare in Brazil and the rest of their range in south-central South America. The Maned Wolf is listed on the US Endangered Species Act as Endangered and on the *2000 IUCN Red List of Threatened Species* as Near-threatened.

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Small predators also underwent persecution in North America in the late 19th and early 20th centuries. Two tiny western foxes that were once considered to be the same species, the Swift Fox (*Vulpes velox*), native to shortgrass prairie, and the Kit Fox (*Vulpes macrotis*) of intermountain and desert grasslands further west, both declined as a result of predator-control programs. Both are shades of tawny, reddish-brown and tan, stand about 1 foot tall, measure 23 to 31 inches long, and weigh less than 5 pounds (Nowak 1999). Although not considered threats to cows or sheep, foxes traditionally have been killed because of their possible threat to poultry. In wilderness areas, they have been killed merely because of predator prejudice. These foxes subsist on small rodents and even insects, such as grasshoppers, and are, therefore, beneficial.

The Swift Fox was named for its speed when streaking across the prairie, clocked at about 25 miles per hour (Turbak 1993). The Canadian populations of the Northern Swift Fox (*Vulpes velox hebes*), native to southern Saskatchewan, Alberta and Manitoba, and the northern edge of the shortgrass prairie that once stretched to Texas, are listed as Endangered on the US Endangered Species Act but are extinct. They disappeared from the wild by the 1930s, after control programs were implemented, and Canadian wildlife authorities have reintroduced Swift Foxes of a related subspecies from Colorado, Wyoming and South Dakota (Nowak 1999). Some reproduction has taken place.

Swift and Kit Foxes began to decline in the 19th century, and Ernest Thompson Seton commented on the vulnerability of this species: "Harmless to man and mankind's interests; and yet he is going fast with all the other innocent and lovely wild things. Yes, faster than most, for he is the least cunning of our foxes--so guileless that he readily takes the poisoned baits used nowadays for killing coyotes" (Seton 1899). In fact, almost none of these foxes was seen in the wild from the early 1920s to the late 1950s, a period of heavy predator-control and poison campaigns (Chambers 1978). Both species have lost the majority of their habitats to agriculture. In North Dakota, the state lists the Swift Fox as an endangered species, with no breeding populations. The last known occurrence of the Swift Fox in this state was in the mid-1980s (Turbak 1993). Further south, this species is known to survive in southwestern Kansas, Nebraska, Montana, Wyoming and South Dakota (Chambers 1978). Some areas of unplowed prairie provide refuge. This fox has been able to colonize on roadsides next to fields and in the few remaining unpoisoned prairie dog towns. Some research has been carried out on the wild behavior and habitat needs of Swift Foxes in the Midwest, and there is room for cautious optimism that increased attention to this little fox will result in strong legislation to preserve it and prevent persecution and poisoning. Author Glenn Chambers was researching an article for *Audubon* magazine, "Little Fox on the Prairie" when he saw a fox family being killed by two farmers who poured gasoline in the den entrance and set fire to it. The male fox, provider of food for the vixen and pups, was found in a ditch a few yards away, his rib

cage ripped out by a high-velocity bullet (Chambers 1978). The vixen had escaped the burning den with two of the pups, but the farmers shot her as she watched over them (Chambers 1978).

Kit Foxes occupy deserts, dry grasslands, and montane areas with scattered trees from Utah north to Washington state and west to California. They prey mainly on kangaroo rats and other small rodents. A subspecies from southern California known as the San Joaquin Kit Fox (*Vulpes macrotis mutica*) is listed on the US Endangered Species Act as Endangered. Settlement and farming of the region reduced their habitat, and predator control has eliminated entire populations, causing them to dwindle to a few thousand animals. This delicate, little buffy-yellow fox is now restricted to a tiny remnant of its once immense habitat of mixed grasslands, deserts and shrub in California. Their original range stretched from San Joaquin and Stanislaus counties in the north to Kern County in the south. They probably numbered at least 12,000 prior to settlement (Turbak 1993). Tame and trusting, they became targets for hunters; even schoolboys with rifles have been seen shooting them as sport (Turbak 1993). One hunter was seen shooting a pair's tiny cubs one after another as they played at the den entrance, then killing the mother when she emerged to protect them (Turbak 1993).

Foxes have been considered threats to livestock and domestic poultry by European settlers. The Cape Fox (*Vulpes chama*) of dry country in southern Africa was the object of control programs by European settlers under the misapprehension that it preyed on domestic poultry. This resulted in declines in the numbers and range of this small, silvery-gray fox (Nowak 1999). The Hoary Fox (*Lycalopex vetulus*) of south-central Brazil, an endemic species of savannah grasslands, is persecuted by local people for presumed predation on domestic fowl (Nowak 1999). Although very shy, it courageously defends itself and its young when threatened (Nowak 1999). Little is known of its status, listed as Data Deficient by the IUCN. Argentine Gray Foxes (*Dusicyon griseus*), native to Patagonian grasslands, have been poisoned by livestock owners who distribute strychnine bait. Their populations have declined in many areas as a result, and thousands of non-target mammals and birds have died from these poisons. Such poisoning is illegal in Argentina, and efforts are being made by biologists and conservationists to stop this senseless killing.

Eight species of foxes are listed as Data Deficient by the *2000 IUCN Red List of Threatened Species*, and two species as Conservation Dependent. This is an indication of the lack of research on these ecologically important species, which perform the important role of consuming large numbers of rodents. Red Foxes (*Vulpes vulpes*), native to North America, Eurasia and northern Africa, have been persecuted as well, hunted as sport in England and parts of the United States, and killed by many farmers and livestock owners. One Midwestern town even rounded up these foxes once a year and beat them to death with sticks. After a *Life* magazine article describing this cruel persecution and the resulting public outcry, it ended. Fox hunting in England may end in the near future as the Parliament has voted to stop this cruel activity.

Bears

The immense Grizzly or Brown Bear, which once roamed the prairies and woodlands of western North America, inspired awe and fear in explorers and settlers alike. For thousands of years, Native Americans revered this bear. The Cree called it a four-legged human, and other tribes considered it a brother or cousin. They felt a kinship based on its intelligence and respected its great strength. They could not easily hunt it with bows and arrows, and when wounded, it showed great courage defending itself, able to cause severe injuries or death with its 5-inch claws.

The Grizzly reigned as the fearsome and unchallenged king of all wildlife on the continent, numbering at least 100,000 prior to the arrival of Europeans (Nowak 1999). These extremely adaptable bears lived in every western North American habitat except deserts. Arriving from Asia by way of the Bering Strait 12,000 years ago when sea levels were lower, Grizzlies gradually colonized western regions, the biggest of an array of large carnivores that inhabited the continent at that time, including dire wolves, hyenas and sabre-toothed cats. They survived the frigid and

harsh climate of the Pleistocene Ice Age. They thrived in prairies, especially those with scattered woodlands. In the 1500s, their range extended from the Arctic tundra south through the shortgrass prairie to the pine forests of northern Mexico, and west to the Pacific Ocean. In fact, the original range of the Grizzly Bear may have been larger than previously thought, reaching east to the Atlantic in Canada. A Grizzly skull has been found in a midden of the late 18th century, and pelts of these bears reportedly were taken in Labrador as late as 1927 (Nowak 1999).

Grizzly Bears of North America and Brown Bears of Eurasia were previously considered separate species, but today they are classified as a single one, *Ursus arctos*. The bears that live along the southern Alaskan coast and offshore islands, such as the Kodiak, are the world's largest carnivores (Nowak 1999). Weighing up to 780 kilograms (1,716 pounds), Kodiak Grizzlies have a shoulder height up to 1,500 millimeters (58.5 inches, or almost 5 feet), and a body length ranging up to 2,800 millimeters (109.2 inches, or 9 feet) (Nowak 1999). Standing height can be almost 12 feet. Adult males are larger than adult females. North American Grizzlies are far larger than bears of the same species native to southern Europe, which average only 70 kilograms (154 pounds) (Nowak 1999). Grizzlies of the northern portion of the lower 48 states are only somewhat smaller than the Alaskan bears, while those native to Arizona, New Mexico and Mexico, all now extinct, were smaller still, weighing less than 1,000 pounds.

Reproducing at a very slow rate, Brown Bear females have an average of two cubs only once every two to four years, and the cubs stay with their mother for this entire period (Nowak 1999). On occasion, only one cub is born, and sometimes up to four. If the mother is killed at any time before the cubs leave to be on their own, the cubs will also die because they are unable to fend for themselves, destroying two generations. The training period of these bears is extremely long, an indication of their slow maturation and the complexity of learning about food sources and other keys to survival. Another reason for this long apprenticeship is the potential of attacks by male Grizzly Bears. Until a young bear is 3 years old or older, it is not large enough to withstand an attack by an adult male, requiring the protection of its mother. Males continue to grow until they are 10 to 11 years old, and may provoke fights with younger bears to chase them from the territory, which prevents inbreeding. Females remain fertile until well into their 20s. Females in the Yellowstone region are known to live to be 25 years old, and Grizzly Bears may have the potential to live 50 years in captivity (Nowak 1999). They do not reach sexual maturity until they are at least 4 to 6 years old. These bears have a low natural death rate, and when combined with their slow reproduction, they are very vulnerable to extinction should they suffer high mortality.

A large habitat requirement is another aspect of their vulnerability. In the Arctic, a single Grizzly requires more than 100 square miles of tundra, and in the Yellowstone area, each bear occupies about 88 square kilometers (Nowak 1999). In regions where they are distributed sparsely, they can be eliminated easily, and even where they are more numerous, persecution and trophy hunting have caused local extinctions.

The strength, intelligence and size of the Grizzly, which have served it so well for thousands of years, were no match for European guns. Explorers, trappers and, later, settlers, slaughtered thousands of Grizzlies, killing them on sight. The first to disappear were the bears of the Great Plains, where the landscape was open and provided little cover. In some cases, these bears showed almost mythic strength upon being shot. Meriwether Lewis of the Lewis and Clark expedition of 1804 reported that one wounded bear ran at a fast clip for nearly a quarter of a mile before it fell dead after being shot through the heart (Peck 1990). Persecution of bears often includes the killing of their cubs. Early in the 20th century, President Theodore Roosevelt refused to kill bear cubs pointed out by his hunting guide, and when this was publicized in newspapers, he became a folk hero as a result. Toy manufacturers took advantage of the story by producing stuffed animal "Teddy Bears," which remain popular today. President Theodore Roosevelt left a legacy of destructive trophy hunting, however, including the killing of many adult bears.

Settlers moving into the West hunted these bears, and during the late 19th and early 20th centuries, government predator-control agents began campaigns to eliminate these bears. Much of the zeal with which the bears were slaughtered was based on a misconception: they were thought to be vicious man-eaters. In fact, they are mainly vegetarian and only occasionally kill animals for meat. The most common animals killed by Grizzly Bears are various types of rodents, such as ground squirrels and, in some areas, fish. Elk calves are killed as part of their diet in some

areas. The staple foods of the Grizzly diet are green shoots, sedges, clover and lilies early in the spring and, later in the summer, berries, roots, fruit, acorns and nuts, with occasional rodents (Peacock 1996). These bears do not consider humans to be natural prey, and attacks are rare. Prejudices dominated, however, and hunters who killed them were considered heroes and rewarded with bounty money. To protect their livestock, ranchers insisted that government hunters kill off every Grizzly Bear, and after several centuries of uncontrolled hunting, trapping and poisoning, the bears became extinct in their vast original realm south of Canada except for a few hundred animals protected in Yellowstone and Glacier National Parks.

All 26 subspecies of Grizzly Bears south of Canada and Alaska, except *Ursus arctos horribilis*, became extinct by the 1950s, and some disappeared during the 19th century. The latter subspecies, named from specimens obtained in northeastern Montana, barely survived. In fact, *Ursus horribilis* was the species' scientific name until recently, an indication of the prejudice against it. Now considered a subspecies, *Ursus arctos horribilis* is listed on the US Endangered Species Act as Threatened, and this subspecies is used to indicate all Brown Bears in the lower 48 states.

Grizzly populations still occupy only 1 percent of their original range in the lower 48 states and number fewer than 1,000 (Nowak 1999). This includes Yellowstone and Glacier National Parks, whose protection prevented their total extinction south of Canada, a few wilderness areas in Idaho, western Montana, and Washington. Human activities such as road building disturb them and cause them to desert otherwise prime habitat. They are no longer the fearless animals that Lewis and Clark encountered, but have become very shy outside of national parks after centuries of persecution. Although they may pose a potential threat to humans who enter their last retreats, people are a far greater threat to them.

Their rugged wilderness habitat in Montana is being developed rapidly, and Grizzly populations, which had risen somewhat after their listing on the US Endangered Species Act, are now in danger of disappearing again. Added to this, some ranchers in the region still persecute them. A prime habitat for Grizzly Bears, the 329,000-acre Swan Valley of northwestern Montana borders the Bob Marshall Wilderness area, a country of open grassland and forest with breathtaking mountain views. Until recently, this landscape remained almost unchanged from its original state. Ranching, road building and other activities, and an increasing human population in this region, however, are now ruining its wilderness character and threatening the Grizzlies (Pelletier and Servheen 1995). Through cooperation with local residents, the Fish and Wildlife Service is identifying important habitat areas and linkage corridors for the Grizzly Bears in this part of Montana to prevent conflict with humans. These zones would be a link between the small population of bears in the Mission Mountains to the west and those in the Bob Marshall Wilderness area (Pelletier and Servheen 1995). The land is a checkerboard of ownership by private individuals, state, federal and corporate entities; in an unusual project, all private and public lands will be included in a management plan, with input by local citizens (Pelletier and Servheen 1995). These bears remain under the continual threat of being shot by ranchers fearful for their livestock and apprehensive about possible land restrictions in areas where Grizzly Bears are resident. Sport hunting of this small population is also allowed.

Grizzly Bears are still depicted in the media as dangerous man-eaters, resulting in a prejudiced view by the American public. A number of television programs produced by the National Geographic Society, CBS, the Discovery Channel, Fox and others have perpetuated this image. With titles such as "Dangerous to Man!," "Bear Attacks" and "Man-eaters," these programs often demonize the bears and interview people who have been attacked while camping in the bears™ habitat. Very few such attacks have occurred, and almost none has been fatal. After centuries of being shot at and harassed by humans, Grizzly Bears tend to avoid people. When camping inside national parks where Grizzlies are resident, special precautions must be taken, and it should be kept in mind that the parks are *their* home, and humans are the intruders. The national parks, where hunting is banned, are their only refuge. Some documented cases of attacks have occurred when a mother bear felt her cubs were threatened by humans, especially if they approached the cubs. Mother Grizzlies may be the fiercest protectors of their young in the animal world, a trait that should be admired from a distance. Television programs that sensationalize the potential threat of animals do not note the hundreds of Grizzly Bears killed by humans every year in North America. They also fail to show the many bears that are merely wounded by hunters and suffer a long death, or the cubs that are orphaned and die of starvation.

The irrational fear and hatred aroused by misinformation often result in mortalities to these bears by armed tourists and residents in their range who misinterpret the bears' behavior. Many bears have had to be destroyed because tourists fed them, and they became fearless, capable of swiping food or destroying tents and property. Information on avoiding Grizzly Bear encounters is available from National Park Service rangers, other federally employed biologists, and many conservation and humane organizations. Only with tolerance, respect and an informed public concerned about preserving these bears can they survive.

Ecotourism in the threatened and unprotected portions of the Grizzlies™ range is in the early stages of development. Portions of the revenues from tours could be spent to acquire habitat and conduct local education programs. In Alaska, this has been highly successful, with tourists coming from around the world to see these bears fishing for salmon. Montana has some of the most spectacular scenery on the continent, sweeping vistas and vast open spaces that rival those of East Africa. They could be a magnet for tourists anxious to see Grizzly Bears and other native wildlife against a background of snow-capped peaks. Unfortunately, much of their prime valley habitats have been taken over by ranchers and private homes. The tourism in the area has been of a highly commercial and exploitative nature. For example, in some Montana towns, tourists see many stuffed Grizzlies in local businesses, and one can have one's photograph taken posed in a cutout painting of a Grizzly Bear appearing to attack.

If sizeable portions of Montana valley habitats were acquired for the Grizzly Bears, tourists could be taken on van tours, similar to those that now operate in East Africa. For the more athletic, groups of tourists could be taken on guided walks into the high country. Portions of the funds from the tours could be used to purchase privately owned land, to fund public education about these bears and their survival, and to compensate ranchers for livestock losses. The Nez Perce tribe is working with the Fish and Wildlife Service on a project to reintroduce the Grizzly Bear into the Selway Bitterroot wilderness of Idaho and Montana, another magnificent area for ecotourism (Robbins 1997).

Plans to reintroduce Grizzlies into the 1.9 million-acre San Juan National Forest in southwestern Colorado have sparked controversy and prejudice (Papich 2000). Decades after Grizzlies disappeared from the state, the Fish and Wildlife Service reintroduction project has been applauded by local conservation organizations, such as the Colorado Grizzly Project, and opposed by ranchers and even hiking groups who fear attacks (Papich 2000). Returning the Grizzly Bear to portions of its former range in the lower 48 states, even into immense wilderness areas, will be a slow process, possible only after extensive education and a change in the accepted practice of releasing livestock in national forests without sheepdogs, herders or other protections.

The Mexican Grizzly (*Ursus arctos nelsoni*) persisted in the remote mountains of northern Mexico until it was poisoned, shot and trapped to extinction in the late 1960s (Day 1981). This race was smaller than northern Grizzlies, weighing about 700 pounds. Quite numerous and widespread, the Mexican Grizzly had an enormous range in the pine forests of the northeast until efforts began to exterminate it. Only about 30 animals remained by 1960. Although some individuals tried to protect these last bears, others set out to destroy them, and a campaign of poisoning, trapping and hunting, sponsored by ranchers, resulted in the killing of the last animal in the early 1960s (Day 1981). In 1968, biologist Carl Koford conducted a three-month survey in the isolated mountain canyons of Chihuahua where they had last been seen, and he saw no sign of Grizzly Bears (Day 1981). Subsequently, they were declared extinct.

Hunters in many parts of the Grizzly Bear's range in Canada kill the species in such numbers that many biologists consider it to be threatened there. The Canadian Broadcasting Company's "Nature of Things" program produced a film, fiGrizzlies: Losing Ground,fl which painted a dim picture of this bear's future in Canada. They are killed by ranchers and hunted for trophies and for their gallbladders, which are used in Traditional Medicine. Many are killed by park rangers merely because they come too close to tourists. They are being driven from their wilderness homes by unrestricted logging and mining as well.

Brown Bears are already extinct in North Africa, Austria, Belgium, Denmark, Germany, Israel, Jordan, Lebanon, Liechtenstein, Luxembourg, the Netherlands, Portugal, Switzerland, Syria and the United Kingdom. They are

endangered in the few countries where they remain in Western Europe. In Scandinavia, there may be as many as 700 Brown Bears, with populations of less than 1,000 in Slovia, Romania and Bulgaria, and possibly 2,000 in the former Yugoslavia (Nowak 1999). Fewer than a dozen Brown Bears survive in France's Pyrenees Mountains where, despite protests from around the world, a major highway was built through the center of their habitat. Brown Bears are heavily persecuted throughout Eurasia for body parts, especially gallbladders. They are considered endangered in Central Asia's mountains where *Ursus arctos isabellinus* occurs, a CITES Appendix I race, and the Tibetan Brown Bear (*U.a. pruinosus*) is listed as Endangered on the US Endangered Species Act. Outside Russia, only about 4,500 to 7,600 of these bears remain in China, and isolated populations survive in Mongolia, northern Japan and Turkey (Nowak 1999).

The South American Spectacled Bear (*Tremarctos ornatus*) is classified as Vulnerable by the IUCN, with persecution by ranchers a major cause (Nowak 1999). These 300-pound black bears have large circles of white fur around the eyes and white circular markings on the neck and chest. They feed on fruit, bamboo hearts, corn, and other vegetation with about 4 percent of their diet composed of rodents and insects (Nowak 1999). Spectacled Bears are native to the Andes of western Venezuela, Colombia, Ecuador, Peru and western Bolivia. This high-altitude, shy bear is active mainly at dusk and at night and poses no threat to livestock, yet ranchers and landowners have persecuted and hunted it in Peru and other countries because of the mistaken belief that it kills livestock (Nowak 1999).

With the destruction of their high-altitude, humid forest and grasslands replaced in many areas by agriculture, some bears have raided corn fields to survive; many of these bears have been shot by farmers (Nowak 1999). This bear is declining throughout its range, and few areas remain where it can forage without being hunted, either by livestock ranchers, farmers, or for its body parts to sell to Asian markets for traditional medicine. Only a few national parks exist within its range, and populations have become fragmented and isolated from one another. A biological study of these bears in Bolivia by British zoologist Susanna Paisley is uncovering new information about their natural history and the threats posed by radio-tracking. A film about her study and the local people helping her, fiBears of the High Andes,fl was shown on a National Geographic Explorer television program in 1998, providing a unique glimpse into the lives of these rare bears.

Otters

The Eurasian or Common Otter (*Lutra lutra*) has been persecuted since the
13th century in Britain, and a dog, the Otter Hound, was bred to hunt it (Chanin 1985). This otter was officially designated as a pest by a 1566 English law, which authorized local constables to offer bounties for their destruction because of their supposed predation on fish (Chanin 1985). At that time, fish ponds on the estates of the wealthy were stocked to supply the tables of the affluent (Chanin 1985). They were also thought to be competitors with fishermen for game fish such as trout. For hundreds of years, high bounties were paid, contributing to their disappearance from many areas (Chanin 1985). Hunting otters with dogs was the only effective manner of pursuit, and in the 16th century, the Assembly of Norwich decreed that fishermen should conduct two or three otter hunts per year to avoid being fined (Chanin 1985). Estate game keepers continued over the centuries to persecute these playful animals in the British Isles, pushing them close to extinction.

In Europe, prejudices are gradually fading, but the Common Otter, despite its name, is no longer common. It has declined drastically in Britain and most of western Europe, and is rare throughout much of its range elsewhere in eastern Europe and Asia as a result of continued persecution, fur trapping, habitat loss and chemical contamination of its environment (Chanin 1985). This species is listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the category designating species in danger of extinction, and in which commercial trade is not allowed between the Party nations. The *2000 IUCN Red List of Threatened Species* classifies the species as Vulnerable. An increasing number of people are becoming acquainted with this delightful

animal. Not until 1978 did the otter receive official protection from hunting and trapping in England and Wales, and in the intervening years, a strong "Save the Otter" campaign, begun by Friends of the Earth, has had positive results (Chanin 1985). Surveys completed during the 1970s found that otters had become extremely rare in England, and were in steep decline. In parts of southwestern England, otters are now increasing with legal protection, and they are being reintroduced into areas where they had been hunted or trapped out. In 1982, protection was added in Scotland, in spite of continued opposition from otter hunters and those who harbored old prejudices (Chanin 1985). In the Netherlands, reintroductions of otters are returning them to long vacant habitat.

Izaak Walton's views of the otter were not scientifically refuted until the 20th century. Best known as the author of the 17th century book, *The Compleat Angler*, a compendium of information about fishing in England, he quoted a fishermen of the times: ". . . my purpose is to bestow a day or two in helping to destroy some of those villainous vermon; for I hate them perfectly, because they love fish so well, or rather, because they destroy so much, indeed, so much, that in my judgment, all men that keep otter-dogs ought to have pensions from the King to encourage them to destroy the very breed of these base otters, they do so much mischief." Scientific studies of otter diets established that these animals did not pose threats to game fish populations. A 1942 study found that North American River Otters (*Lutra canadensis*) prefer slow-moving forage fish, such as suckers, mudminnows and sticklebacks, to fast-moving trout. Some game fish are taken, but subsequent studies established that such fish make up a small percentage of the otter's diet. A 1955 study by biologist Richard Ryder examined stomachs of River Otters (*Lutra canadensis*) trapped in Michigan and found forage fishes (primarily mudminnows) in 56 percent, crayfishes in 22 percent, amphibians in 17 percent, insects in 13 percent, and trout in 13 percent of all otters examined. Ryder concluded that otters are opportunistic feeders, catching prey items in proportion to their abundance and in inverse proportion to their swimming ability. Thus they benefit game fish by removing overpopulated fish species that compete with trout for food from streams and waterways. In a dramatic demonstration to illustrate its food preferences, a River Otter was placed in a large tank with both trout and crayfish. Ignoring the fast-moving trout, the otter went directly for the crayfish.

Other species of otters also have been found to prefer slow fish, especially bottom-dwellers not desired by either sport or commercial fishermen. Yet they are still being persecuted in many parts of the world. The Marine Otter (*Lutra felina*), a small otter native to the Pacific coast of western South America, has been so persecuted by fishermen for alleged damage to fisheries (Nowak 1999) that it is now listed as Endangered on the *2000 IUCN Red List of Threatened Species*. The Sea Otter (*Enhydris lutris*), protected from previous hunting for the fur trade, began to recover its numbers in the North Pacific, but has recently declined to Endangered status as well as a result of persecution by fishermen, oil spills and predation by Killer Whales.

One young California Sea Otter filmed by Jacques Cousteau became very tame, cavorting with the cameramen and allowing itself to be petted. A few days after the Cousteau crew left the area, this young otter washed up dead on the beach, having been shot. It was conjectured that this friendly otter had approached a boat with fishermen who shot it. Fishermen have overharvested abalone beds for these extremely valuable mollusks and blamed Sea Otters for depleting them, yet abalone form only a small part of their diet. Some Sea Otters eat no abalone at all, specializing in other foods. Moreover, they eat sea creatures that prey on the kelp, without which abalone and other wildlife would not flourish. This species is considered a positive element in the ecosystem.

River Otters in North America were persecuted by European colonists, many of whom shot them on sight. These animals, described by early explorers as highly visible, bold and playful, became shy, secretive and nocturnal after centuries of persecution and fur trapping in the United States and Canada. By the 1950s, they had disappeared altogether from vast areas in the country, from Pennsylvania south to northern Georgia and throughout the Midwest south of Michigan and Minnesota, west to Utah (Nilsson 1985). Beginning in the 1970s, reintroductions of otters live-trapped in Canada, Michigan and other areas where they are still relatively common, have taken place in West Virginia, Arizona, Tennessee, upstate New York, Missouri and several other Midwestern states. In some cases, the reintroductions have failed, but for the most part, the North American River Otter is on the way to reoccupying its original range.

Otters are not regarded benignly by fish hatchery managers and commercial catfish farmers in the South. State Fish Departments and the Fish and Wildlife Service operate hundreds of hatcheries throughout the country, raising trout and other fish. Many of these are non-native species, such as Brown Trout, a European species, or native species, such as Rainbow Trout, that are released far from their natural ranges for the benefit of sport fishermen. These hatchery programs are regarded negatively by many ecologists who have documented that the released fish often cause great damage to ecosystems, outcompeting native fish and introducing diseases. Yet state and federal agencies conduct control programs on otters who raid their ponds. Rather than screen the ponds from otters, who can hardly be blamed for finding hatchery fish easy to catch, these authorities have had laws changed in many states to allow shooting and trapping of otters that come onto hatchery property. Placing screening over fish ponds and hatcheries--and fencing them--will prevent otters, as well as fish-eating birds such as egrets, herons, Ospreys and Bald Eagles, from preying on the fish being raised. This should be carried out instead of lethal methods, which also sometimes kill protected waterbirds. Such control programs do not achieve success in any case because even if depredating River Otters are killed, other otters will be attracted to the ponds, replacing those killed.

Eleven species of otters are listed by the *2000 IUCN Red List of Threatened Species*, four as Endangered, three as Vulnerable, one as Near-threatened, and three as Data Deficient. This represents a high rate of threat, 85 percent, as the otter, or Lutrinae family, has only 13 species. Otters tend to be thinly distributed in their ranges, wide-ranging, slow-reproducing and long-lived--all qualities that make them vulnerable to population declines.

Seals and Sea Lions

The Caribbean or West Indian Monk Seal (*Monachus tropicalis*) was the first animal seen by Christopher Columbus in the New World in the late 15th century, and his crew slaughtered these seals on an islet off the coast of Hispaniola (Day 1981). The only seals native to the Caribbean, they were quite large--6.5 feet long (Nowak 1999). They were heavily exploited beginning in the 17th century for their oil, which was used as a fuel for lamps and, later, for their fur. Scattered populations of the Caribbean Monk Seal survived on islets and beaches far from human habitation until the 20th century (Nowak 1999). Even these last seals were persecuted by fishermen who regarded them as competitors. The last known population of these seals lived on the Triangle Keys, small sandy islets off the Yucatan Peninsula of Mexico, and in 1911, fishermen slaughtered every one of the remaining 200 Monk Seals (Day 1981). Although a few seals were seen after that time, including the sighting of a small colony on a bank midway between Jamaica and Honduras in 1952, an aerial survey of all possible habitats carried out in 1972, and a 1980 expedition, failed to find any sign that the Caribbean Monk Seal remained alive (Nowak 1999). The species was officially declared extinct a few years later, although a few recent reports have given hope that the species may have reappeared (Nowak 1999).

The Japanese Sea Lion (*Zalophus californianus japonicus*), a subspecies of the California Sea Lion, was native to Japan, North Korea, and South Korea, and shooting by fishermen played a major role in its extinction (IUCN 1978).

Commercial fishermen have been responsible for the near-extinction of the Mediterranean Monk Seal (*Monachus monachus*). Once common along the coasts of the Mediterranean Sea, and along the Atlantic coasts of northwestern Africa, this seal is on the verge of extinction, its status listed in the *2000 IUCN Red List of Threatened Species* as Critical. Although resort and industrial development contributed to its decline, shooting by fishermen has been the major cause (Nowak 1999). Many seals drown when they become entangled in fishing nets as well. In past centuries, these seals could be seen on beaches along the Mediterranean, where they would have their pups. After severe persecution, however, they began to hide in the remote caves along the coasts and on uninhabited islets (Attenborough 1987).

In 1981, Greek fishermen threatened to kill off all the remaining Monk Seals on Greek shores if they were not paid compensation for the fish the seals would eat. The Fauna and Flora Preservation Society (now Fauna and Flora International), a London-based organization, raised the money after public appeals in newspapers, which amounted to several thousand dollars.
Fishermen throughout the region became even more intent on eliminating these seals after commercial factory fishing ships began to deplete fish stocks in the Mediterranean.

In spite of legislation protecting the seals, fishermen continue to shoot these seals, which are suffering from lost food supply in most areas. The once pristine waters are now overloaded with sewage and contaminated by chemical and oil spills (Attenborough 1987). The total population of this seal was fewer than 350 in the late 1980s (Attenborough 1987). A 1996 survey found 288 animals, mainly along the African coast in the Atlantic (*BBC Wildlife* 1996). Unfortunately, the largest population in the African islands was decimated in 1998 by a die-off, apparently caused by toxic chemicals.

Mediterranean Monk Seals are extinct in Cyprus, Lebanon, the Canary Islands and Syria, and probably extinct in most other Mediterranean countries. Researchers are conducting radio tracking studies of young seals to discover breeding calves with the goal of reintroducing the seals in the Canary Islands where they have been extinct for over 400 years (*BBC Wildlife* 1996).

The attitude that seals and other fish-eating animals are depriving humans of food is prevalent in many parts of the world and has resulted in the killing of countless fish-eating mammals and birds. The Marine Mammal Protection Act (MMPA) of 1972, which prohibits killing marine mammals in US waters, allows killing of "depredating" seals and sea lions under permit. Such permits are given to kill seals destroying nets to steal fish and/or having a deleterious effect on commercial fish species through their predation. Some Alaskan fishermen, who net the largest fish catches in the world, still resent that the fish are taken by seals and other marine mammals in their waters, and illegal shooting of these protected mammals frequently occurs. Sea lions along the coasts of California, Oregon and Washington have been shot illegally by the hundreds since the MMPA went into effect, and many permits have been given for legal killing. These killings have had a negative effect on many populations of these sea mammals.

Wild Cats
While it may be difficult for most Americans to think of the regal Cheetah as vermin, in the southern African country of Namibia, cattle ranchers treat these endangered and beautiful cats as enemies, trapping and shooting, and even poisoning them. White South Africans have acquired huge landholdings to raise cattle at the expense of the environment in this arid land, fencing off large sections from native wildlife. The majority of Namibian ranchers lack compassion or respect for this graceful cat and, without any compunction, kill females, young kittens and any adult Cheetah on their properties, whether or not the animals pose a threat to their livestock. One rancher told American conservationist Laurie Marker, who is seeking to reverse this trend, that he personally had killed 160 Cheetahs on his property. Marker has taken on the daunting task of trying to convince ranchers of the importance of protecting these endangered cats.

Cheetahs are the world's fastest land animal, reaching 70 miles per hour in pursuit of gazelles, foals of large ungulates, such as zebra and, occasionally, smaller mammals, such as hares. For hundreds of thousands of years, they have adapted to changes in the environment of their once vast range, and are superbly designed as predators. In the North American Pleistocene, more than 10,000 years ago, a cheetah-like cat ranged over the continent, preying on the Pronghorn, the world's fastest hoofed animal. This cat became extinct, perhaps as a result of hunting by Pleistocene hunters.

Prior to the 20th century, Cheetahs remained common in savannah habitats south of the Sahara, and in 1900, their population may have totaled 100,000 animals. Since then, a steady decline in their populations and a shrinking of their range have placed them in endangered status. Cheetahs underwent a dramatic decline in the 1960s when spotted cat fur became fashionable. US imports were stopped when the species was listed on the US Endangered Species Act in the late 1960s, and commercial international trade became illegal when Cheetahs were included on Appendix I of CITES in the early 1970s. Killing them for the fur trade devastated their populations because they are distributed so sparsely over their range--even a kill of a few thousand in each country endangered them. Added to this, they have endured persecution by livestock herders and ranch owners, combined with loss of savannah habitat and their prey species. In areas where there are large populations of Lion and hyena, adult Cheetahs and their cubs are preyed upon by the latter predators, who also steal their kills (Hunter 1998). Trophy hunting also has taken a toll on these cats.

By the early 1970s, they numbered only 15,000, according to Peter Jackson, head of the Cat Specialist Group of the World Conservation Union (Newman 1997). Cheetah biologist Luke Hunter (1998) estimates their total population today at a maximum of 12,000 animals, with safe populations in only five or six of the 26 countries where they may be present. In parts of southern Africa, Cheetahs were numerous until a few decades ago when white ranchers fenced off thousands of square miles of grassland. Within these ranches, which cover much of the land area in Namibia and Botswana, landowners killed off predators as well as native ungulates. The once abundant wildebeests, zebras, oryx, gazelles and antelope that migrated in the hundreds of thousands in this region became reduced to scattered numbers.

Namibia, with its arid, open habitat, still has about 2,500 Cheetahs, perhaps the largest population in Africa, but at the present rate of killing by ranchers, they will be extinct there within a decade. In the 1980s, 1,000 Cheetahs were killed by ranchers, and the Namibian Cheetah population dropped about 50 percent between 1984 and 1994 (Schick 1994).

A 1997 PBS television special, fiIn the Wild,fl featured actress Holly Hunter traveling to southern Africa in search of Cheetahs. A visit to Namibia's Etosha National Park, where these cats were once fairly common, failed to find a single Cheetah, in spite of expert help from native Bushmen trackers. An outbreak of Anthrax, spread by domestic livestock, had recently occurred in the park. Some 20 Cheetahs had died, and the disease also killed elephants and other wildlife.

Marker co-founded the Cheetah Conservation Fund in 1990, and since it has been in operation, it has changed many ranchers from Cheetah-haters to Cheetah-protectors. Few knew of the Cheetah's worldwide plight, and many cooperated when informed. One successful strategy to protect livestock introduced by Marker has been the use of donkeys to guard cattle herds. These animals easily fend off Cheetahs with their powerful kicking hooves (Schick 1994). Baboons have also been trained to guard livestock because of their aggression toward Cheetahs (Schick 1994). Recommendations such as bringing cows closer to homesteads during calving season have also been made to ranchers (Schick 1994). Many ranchers did not realize that Cheetahs prey on livestock only when their own natural prey, primarily gazelles and Impalas, have become scarce because of killing or fencing by the ranchers (Schick 1994).

Within the past few years, many ranchers have been convinced to use box traps to capture Cheetahs unharmed instead of killing these cats. Marker ear-tags the animals and returns them to local protected areas (Schick 1994), or arranges to have them moved. In the early 1990s alone, 75 Cheetahs were removed from ranches where they were being persecuted and were introduced into other areas. One farmer caught a female with five cubs and wanted to keep the cubs as pets. Marker convinced him to give up the female and four of her cubs, but he insisted on keeping the largest one. Although keeping Cheetahs as pets is not good for their welfare or conservation, it is an improvement over their wholesale destruction. Leghold traps are used by some ranchers, and in 1996 Marker acquired two 3-week-old Cheetah cubs whose mother had been killed in one of these traps. They will have to remain in captivity because of their young age when orphaned.

An organization known as Africat has sponsored the capture and transport of 100 wild Namibian Cheetahs to South Africa. This organization reports that ranchers capturing Cheetahs in large box traps often sell them to breeders rather than reintroduction programs, a practice that it does not condone. Translocating adult Namibian Cheetahs to South African reserves where they had become extinct has been very successful. In one case in 1995, three males were

released in Madikwe Game Reserve where four other Namibian Cheetahs had been introduced in 1994, and all survived. A male, four females and five cubs were released in Pilanesburg National Park in 1995, and there were no fatalities (*Oryx* 1996). Most of South Africa's Cheetahs were eliminated by Boers in the 19th century, and the government is now returning them to their original range within national parks. Outside of national parks, they may be in as great danger as the Cheetahs further north.

Lions have continued to decrease in Africa south of the Sahara from a variety of factors, of which persecution by livestock raisers is a major one. Outside of national parks, these big cats have become rare or absent, and in 1996, the species was first listed by the IUCN as Vulnerable. The *2000 IUCN Red List of Threatened Species* also classified the African Lion as Vulnerable. They disappeared long ago from areas with scarce ungulate populations and large numbers of herdspeople who persecuted them, such as the arid regions of southern Africa and the sub-Saharan. In recent years, they have declined throughout the continent. Outside of parks, the Maasai and other tribes with livestock herds routinely kill Lions and other predators to protect their cattle (Hunter 1998). Lions are particularly vulnerable to persecution and hunting because, like wolves, they hunt in groups. When persecuted, they may not be able to survive hunting alone or in pairs.

Some parks are not large enough to maintain healthy Lion populations, and when they leave parks to wander in search of prey, they are often killed by ranchers or hunters. In the southern African country of Namibia, for example, the 300-mile-long, 25-mile-wide Skeleton Coast National Park skirts the Atlantic coast. Two filmmakers, Jen and Des Bartlett, chronicled the disappearance of Lions from the park. A small population of Lions inhabited the park in the early 1990s, and one pair was radio-collared by park rangers. Shortly thereafter, both Lions were shot dead by livestock herders when the Lions left the park. The Bartletts had known the female for five years, and she was pregnant with four cubs when shot. The killing of Lions to protect livestock is legal in Namibia, and with the death of the last specimen in the park, an elderly and emaciated animal shown in their National Geographic Society film, fiSurvivors of the Skeleton Coast,fl these great cats are now extinct in the area.

Wild cats have been hunted heavily and killed off throughout the Middle East. Leopards (*Panthera pardus*) still persist in small pockets, escaping detection with nocturnal hunting, and hiding in rock crevasses and trees during the day. As a general rule, wherever Leopards are seen in the Middle East, they are shot or poisoned as potential threats to the ubiquitous sheep and goats. In a few areas, such as remote portions of the Saudi Arabian Peninsula, Leopards are protected in national parks. These Leopards are very adaptable in their prey and can subsist on small animals, such as hares--unlike the Lion, which requires larger prey.

Eight subspecies of Leopards are listed on the *2000 IUCN Red List of Threatened Species*, all in Endangered or Critical categories. They range from North Africa across Asia to Java, Indonesia. Races such as the South Arabian Leopard (*Panthera pardus nimr*) of Saudi Arabia, United Arab Emirates and Yemen; North Persian (*P.p.saxicolor*) of Afghanistan, Iran and Turkmenistan; and the Anatolian Leopard (*P.p.tulliana*) of Turkey, have populations so small that they may become inbred and disappear within a few decades. The South Arabian Leopard is the focus of a conservation program organized by officials and conservationists from Saudi Arabia, Yemen, Oman and the United Arab Emirates. Only 100 to 200 of these cats survive, and they continue to be persecuted by livestock owners and hunters (*Oryx* 1996). The "Leopard Group of Arabia" was formed in 1995, and each country will prepare a plan for conservation of the Leopard, review its own wildlife legislation, conduct surveys, and make proposals for protected areas (*Oryx* 1996). This group is also working to increase populations of native prey, reduce livestock numbers in the Leopards™ habitat, and conduct public education programs (*Oryx* 1996).

Snow Leopards (*Panthera uncia*), native to the mountains of Asia, from Pakistan east to China, are endangered from hunting for pelts and as trophies, and by persecution from herdsmen who kill them as a threat to their livestock. Their total population may be as low as 4,500 or as high as 7,500 (Sunquist 1997). In their stark, rocky and high desert habitats, these cats prey upon wild sheep, goats, deer and marmots (Sunquist 1997). Their original range stretched for 4,000 miles and encompassed 1.2 million square miles in a wide arc, curving from east to west in the Himalayas through former Soviet Republics, Nepal, Pakistan, Afghanistan, Bhutan, Sikkim, and Mongolia to China, including a

total of twelve countries (Baillie and Groombridge 1996). They have disappeared from vast areas within this region, however, and continue to decline.

Until the 20th century, few herdspeople roamed these remote and forbidding regions, and Snow Leopards and their prey were left unmolested in most areas. In the past 50 years, however, human populations have risen dramatically. In western China, the government has used subsidies to encourage settlement of the western steppe, and large numbers of people have entered previously uninhabited areas with their livestock. In western Nepal, villages now dot the Himalayan slopes at 9,800 feet, and people scratch out a living from meager potato, barley and wheat crops (Sunquist 1997). Each household has only a few sheep and goats and cannot afford to lose even one to predators (Sunquist 1997).

Some 1 million Mongolian herders subsist in a barren landscape, dependent on their yaks, goats and sheep. These people, whose livestock compete with wildlife for the scarce grasses, also hunt native animals which the Snow Leopard needs to survive--Blue Sheep, ibex, deer and others. Even marmots are killed in very large numbers for their meat and skins (Sunquist 1997). When their natural prey disappears, and Snow Leopards begin to prey on livestock, herders poison, trap or shoot these cats in retaliation. In many areas, herders kill Snow Leopards as a potential threat, even when they have not lost livestock, in order to sell their valuable pelts.

Dr. George Schaller of the Wildlife Conservation Society has conducted studies on the diet of Snow Leopards and, in most areas, found less than 5 percent of livestock in their diet, based on feces analyses (Schaller 1998). As numbers of livestock in the Snow Leopard's range rise and herders penetrate further into the mountains and high pastures, livestock losses occur that sometimes result in extermination campaigns (Schaller 1998). Herding practices in these areas often encourage predation by Snow Leopards, with sheep and goats, and mares with their foals left unguarded (Schaller 1998). Depletion of their prey has increased in recent years, with government policies that encourage marmot hunting, pika poisoning and, until the late 1980s, Blue Sheep market hunting (Schaller 1998).

In Tibet, Dr. Schaller has arranged with local herdspeople to pay them for any losses they incur to Snow Leopard predation, and he has hired local Tibetans to assist in field studies of these cats, giving them a financial incentive to protect the cats. Likewise, in Pakistan, a new program organized by an American conservationist, Helen Freeman, founder of the Seattle-based International Snow Leopard Trust, has sponsored some 90 projects for the species, including many field studies. Its web page (www.snowleopard.org/islt) follows the movements of radio-tracked Snow Leopards. Gary Larson, the popular *Far Side* cartoonist, created a Snow Leopard design for the organization to use on its shirts (Sunquist 1997). Grade-schoolers all over the country have raised money by selling T-shirts for the International Snow Leopard Trust. In 1988, through the education programs and compensation for livestock losses conducted by this organization, a Pakistani livestock owner trapped a young Snow Leopard found preying on livestock, contacted the government and, before news crews, set it free. In the past, it would have been killed routinely.

The International Snow Leopard Trust and the Mongolian Association for Conservation of Nature and Environment are providing tea, noodles and clothing to livestock grazers in Snow Leopard territory in the Altay Mountains of Mongolia, with the understanding that they will protect wildlife (Schaller 1998). One village requested children's clothing, flour, candles, soap and tea, and these requests were filled (Sunquist 1997). The concept of involving local people in the conservation of wildlife is extremely important and, wherever practiced, has had beneficial long-term results for all concerned.

Bats

Bats live on every continent except Antarctica and serve extremely important ecological roles as pollinators, seed

dispersers and consumers of vast quantities of insects. Although some societies value these useful animals, many persecute all bats, based on irrational prejudice and fears of rabies. The Romanian legend of Dracula, in which a man turns into a blood-thirsty vampire bat at night and flies about seeking victims, has created a ridiculous and false impression. Real vampire bats are small, only about 3 inches in length and weighing about an ounce (Wilson 1997). The three species inhabit neotropical forests and are rare in natural habitat. Only when large numbers of livestock are grazed in an area do these mammals, who suck blood from large animals such as livestock, become common (Wilson 1997). They rarely cause the livestock harm. They are capable of transmitting disease to their host animal, but very rarely do so (Wilson 1997). Bat Conservation International has worked effectively to allay fears about vampire bats and helped many people to see them in the positive light of their value to ecosystems, economies (through pollination), seed dispersal and insect control and their interest as diverse, successful species. But Dr. Merlin Tuttle, founder and Executive Director of the organization, believes that persuading the public that bats are not to be feared is still an uphill battle, in spite of progress made in education programs (Raver 2001). Exaggerated headlines about bats and rabies tend to undo rational education programs. In fact, Dr. Tuttle says that over the past 20 years, the United States has had 1.5 human cases of bat rabies per year, hardly deserving the hysteria that so many people feel at the mere mention of bats (Raver 2001).

One positive change in recent years is the increase in people who rise to the defense of bats when newspaper stories appear about the threats of vampire bats and bat control in buildings (Garvin 1999, Gross 2000). Letters to the editor often make the point that bats are basically beneficial, and articles depicting them as fearsome enemies are misleading and cause persecution of wild bats. One article in *The New York Times* (Gross 2000) profiled a bat control professional who paid house calls when people complained of bats having entered their homes. He set glue traps, which bats blundered into and then broke their necks, and sent their bodies to a laboratory in the state capital for rabies testing (Gross 2000). Experts have found that only 1 to 4 percent of bats are rabid, and conservationists suggest that bats be set free rather than killed (Gross 2000). A more humane approach to the problem of bats in the attic was developed by Cal Kosky, a wildlife biologist with the Pennsylvania Game Commission. He tapes a piece of plastic or netting over the top of the entrance hole on the outside of the house (Raver 2001). Bats are able to fly out, but are blocked on return. A bat house is placed strategically close to the old hole to provide them with a new home (Raver 2001). Bat Conservation International has an educational video, "Building Homes for Bats," which explains how to construct bat houses to attract bats to backyards where they eat mosquitoes and other insect pests (Raver 2001).* Sensible advice can also be obtained from Dr. Tuttle's 1988 book, *America's Neighborhood Bats. Understanding and Learning to Live in Harmony with Them*.

Prejudice against bats has had serious consequences for many populations that roost in accessible places, such as open caves. The largest bat colony in the United States, located in Eagle Creek Cave in Arizona, had 30 to 50 million individuals until the 1960s, when vandals and human disturbance reduced them to only 30,000 (Wilson 1997). Several species of North American bats have become endangered as a result of deliberate killing by people, disturbance by spelunkers, and tourists entering the caves (Nowak 1999). The Gray Bat (*Myotis grisescens*) and the Indiana Bat (*Myotis sodalis*) of the eastern and Midwestern United States, for example, are both endangered as a result of these activities. Dr. Tuttle has found that the total number of Gray Bats in 22 major summer colonies declined from 1.2 million prior to 1968 to 293,600 in 1976, a loss of 75 percent (Nowak 1999). The Indiana Bat fell from 640,361 in 1960 to 459,876 in 1975; by 1993, 347,890 remained (Nowak 1999). Both species are listed as Endangered by both the *2000 IUCN Red List of Threatened Species* and the US Endangered Species Act. In Europe, the Pond Bat (*Myotis dasycneme*), a related species, has been reduced to only 3,000 in western Europe and fewer than 7,000 in its entire range (Nowak 1999). It is listed as Vulnerable by the IUCN. Many other European myotis bats also have declined to Endangered or Threatened status from habitat loss, disturbance of hibernating colonies in caves and mines, and blocking up of nursery sites in large buildings, such as cathedrals and castles (Nowak 1999). Rather than killing bats that roost in buildings, or blocking up entries, Bat Conservation International encourages the placement of bat houses nearby, which the bats tend to occupy instead. Similar efforts are needed in Europe. Even when allowed to roost in buildings, many bats are poisoned by chemicals used to treat wood in western Europe (Nowak 1999).

Bat caves are often vandalized when bats hibernate in the winter. Vandals enter caves and knock semi-conscious bats

to the ground, killing them by the thousands, or even millions. Even entering a hibernation cave can result in mortality because disturbances can arouse them and they use up so much stored energy that they do not survive the winter (Wilson 1997). Many bat caves now have gates that allow bats to fly through the open grating, but keep people out; they have helped protect important bat hibernation areas where bats from large areas congregate (Wilson 1997).

The importance of bats as pollinators is discussed at length in *The Natural History of Pollination*, by Michael Proctor, Peter Yeo and Andrew Lack (1996). Many types of flowers have evolved to be pollinated by bats, opening only at night. Their internal pollen-carrying structures are designed to drop pollen on the bat's face when it feeds on nectar (Proctor *et al*. 1996). A great variety of bats and plants coexist, perfectly adapted to one another. Dr. Tuttle's dramatic photos of many such flowers have been published in *National Geographic* magazine and in the useful book, *Bats in Question. The Smithsonian Answer Book* (Wilson 1997). He also has made films of bats for nature documentaries. Many bats are extremely attractive, and their sonar is so complex and sensitive that it is only partially understood by scientists. *Walker's Mammals of the World*, by Ronald Nowak (1999), is another important source of information on bat biology, taxonomy, behavior, conservation and related subjects.

After rodents, bats have the greatest number of species of any mammals, with the most diversity in tropical areas. The number of threatened species has increased dramatically over the past decade as a result of persecution, killing for food, pesticides and other toxic chemicals, and loss of their habitat (see Appendix for list of threatened species). The majority of species at risk suffers from a combination of these factors.

*This video can be ordered online at www.batcon.org or by calling 1-800-538-BATS.

Birds of Prey

Birds of prey have been persecuted for hundreds of years in Europe and other parts of the world, usually as suspected predators of chickens or small livestock, such as goat kids or lambs. In most parts of the world, they still are given no official protection.

Hawks, eagles, owls, falcons and other birds of prey that breed in North America were excluded from the 1918 Migratory Bird Treaty Act (MBTA), signed with Great Britain on behalf of Canada. The Treaty covered almost all other species of native birds, banning hunting and killing as well as harassment and destruction of nests. This exposed birds of prey to continued indiscriminate shooting for sport, hunting from aircraft, poisoning and even capture in pole traps, which catch birds by the feet and hang them upside down in nooses.

Populations of birds of prey that breed in Canada and the northern United States migrate south during the fall, some to Latin America and others to southern states. Flying along thermal wind currents, they funnel into flyways as they pass through mountain chains. In the eastern United States, thousands of hawks, and a smaller number of eagles and falcons, pass over the Allegheny Mountains of Pennsylvania during October, November and December every year. Kittatinny Ridge, near the town of Kempton, came to be known as Hawk Mountain because of the huge numbers of birds of prey passing near it. For generations in the 19th and early 20th centuries, hunters gathered every fall on the rocky ridge to shoot these birds by the hundreds as they soared by. Dead hawks, falcons and eagles accumulated in huge piles, while wounded birds staggered around or lay helplessly immobile on the ground (Brett 1973).

This carnage was considered a form of sport, justified by old prejudices. Rosalie Edge, an ardent conservationist, spearheaded the movement to stop this hunt in the 1930s (Brett 1973). This courageous woman publicized the slaughter of birds of prey, and after a campaign in which she enlisted the help of influential conservationists, she succeeded in purchasing the mountain as a sanctuary (Brett 1973). Edge persuaded an ornithologist, Maurice Broun,

and his wife, to oversee the sanctuary and prevent hunting. They remained on Hawk Mountain for 32 years and served as guides for the more than 40,000 visitors who come every year to see the spectacle of hawks flying over and alongside the mountain ridge (Brett 1973). Rosalie Edge died in 1962, but the sanctuary continues as a non-profit organization staffed with ornithologists, educators, and volunteers, who chronicle by species and number the birds that fly past the ridge.

Hawk Mountain Sanctuary is one of the country's first examples of private ecotourism, and it has accomplished a great deal in teaching the public about birds of prey as useful animals in ecosystems, as well as providing exciting views of these birds as they soar past the ridge. In the morning, before the thermal winds warm up, hawks fly at low elevations, giving visitors a view of their tails and backs from above, an especially colorful sight in the case of the Red-tailed Hawk (*Buteo jamaicensis*), while in the afternoon, they fly higher, transported along by the thermals. Sometimes a visitor to Hawk Mountain can see a hawk or other bird of prey at close range, only 15 or 20 feet away, as they fly close to the ridge, the intricate patterns of their feathers in full view.

In spite of the preservation of Hawk Mountain and several other key hawk habitats, legal protection from hunting did not come in the United States until 10 years after the death of Rosalie Edge. During these years, thousands of hawks and other birds of prey were shot because of ignorance or as sport. Little was understood about their value in controlling rodents and rabbits. In 1960 alone, 12,000 Golden Eagles (*Aquila chrysaetos*) were killed in Texas in a massive campaign to eliminate them. A major victory for birds of prey was their addition to the Migratory Bird Treaty Act in 1972. The bans on hunting that have protected other native land birds were finally accorded these raptors. This was carried out through a memorandum enacted with Mexico, which had signed the Migratory Bird Treaty Act in 1936. It prohibits, except as allowed under specific conditions, the taking, possession, purchase, sale, or bartering of any migratory bird, including the feathers or other parts, nests, eggs or migratory bird products. "Taking" is defined as pursuing, hunting, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, or collecting migratory birds. Individuals and organizations may be fined up to $5,000 and $10,000 respectively, and those convicted may face up to six months imprisonment for misdemeanor violations of the Act. Felony violations may result in fines of up to $25,000 for individuals and $500,000 for organizations and up to two years imprisonment for those convicted. This strong legislation has not stopped the killing of birds of prey altogether, but it has deterred the type of slaughters that were once common.

Although Bald Eagles were revered by native tribes, especially those in the Pacific Northwest, they became victims of prejudice by European colonists, who accused them of damaging fish stocks. A bounty in Alaska resulted in the killing of some 150,000 of these eagles between 1917 and 1953. This species is the national bird, the official symbol of the United States of America, yet historically it has been given little respect. Some even called them "gangster birds" because they were thought to be scavengers of fish caught by other birds. In truth, they are superb fishers with extraordinarily keen vision and are acrobatic in flight. Bounty programs and random shooting of Bald Eagles from colonial times onward caused these birds to disappear from much of their original range, which encompassed the entire continent of North America, including arid regions in the Southwest.

The Bald Eagle Protection Act was enacted in 1940 to protect it from extinction, and amended in 1962 to extend protection to Golden Eagles, primarily to protect immature Bald Eagles, which resemble them. A 1972 incident involving the slaughter of hundreds of Golden Eagles by western ranchers shooting from aircraft resulted in increasing fines under the law from $500 to $5,000 and/or one year imprisonment for subsequent offenses. The amendments also specifically included poisoning in the definition of taking, since both Bald and Golden Eagles had been poisoned by ranchers. These amendments also included the same high penalties for possession of eagle feathers, nests or eggs, and made federal grazing permits subject to cancellation for violations of the Act. In addition, they added a new facet to the enforcement of the Act: one-half of any fine can be paid to a person who provides information leading to a conviction. To augment this protection, the Airborne Hunting Act was enacted in 1972 to prevent the killing of wildlife from aircraft.

After 1973, the killing of a Bald Eagle constituted a violation of the US Endangered Species Act, the Bald and Golden

Eagle Protection Act, and the Migratory Bird Treaty Act, the combined penalties of which could amount to long jail sentences and very high fines. In spite of all these legal steps taken to protect eagles, killings continue. Many are deliberate and carried out in remote areas where there is little fear of prosecution, and others are done by hunters ignorant of the law or the identity of their targets. The protection of native birds, their identification, and laws applying to them should be taught in schools in North America, but such information is usually acquired by chance if at all. Each year, 300 to 400 eagles--Bald and Golden--are found dead. In some cases, hunters still believe folklore about birds of prey being destructive, and shoot them intentionally. A Bald Eagle shot in Maine in 1994 was killed by an 85-year-old man who deliberately killed the bird because he believed these birds were killing geese. He told game wardens that they should "do something about the eagles;" because of his age, he was only given a $2,500 fine, which was suspended. Bald Eagles feed mainly on fish and are not major predators of waterfowl.

Although the majority of eagles are killed when shot, many are found wounded, some in emaciated condition, unable to fly to obtain food and near death. One such Bald Eagle was found crippled in 1983 in Georgia, having been shot in the wing. He had been on the ground for a week, his wing bone exposed. In spite of attempts to save his wing, veterinarians had to amputate it because of infection, and the eagle was taken into a rehabilitation program. Named Osceola, he has played an important role in Wings of America, an education program at Dollywood in Tennessee. John Stokes, Osceola's caretaker, teaches children and adults about the effects of such shooting, stressing the impoverished life that Osceola leads, unable to fly and be free. Stokes decided to bring Osceola along on his hang-gliding trips to treat the bird to some of the sights the eagle had not seen in the many years since being shot. Harnessed into a specially made sling, the pair hang-glided, with Osceola positioned above Stokes, looking intently at the ground far below, turning his head frequently in apparent fascination. The film of Osceola hang-gliding was shown on nationwide television in 1996, and some 500,000 people attend lectures featuring this maimed eagle every year. The National Audubon Society series for young people, "Audubon's Animal Adventures," featured Osceola in the program entitled "Eagle Adventures," shown on the Disney channel.

In the past, it was impossible to prosecute offenders unless there were witnesses or other direct evidence to the killing. Today, a state-of-the-art forensic laboratory run by the US Fish and Wildlife Service in Washington state is able to necropsy dead eagles for cause of death. If shot, ammunition extracted from the birds is analyzed forensically, and cases are made with as much precision and scientific evidence as criminal investigations in which people are the victims.

Prejudices against birds of prey still persist among many who wrongly believe that they harm wildlife or present major threats to domestic animals. Biological studies have documented their ecological importance as major controls on rodent populations. Some birds of prey feed on snakes, insects or other potential pests. No species of raptor poses a significant threat to domestic animals.

The continent's densest population of birds of prey breeds in the craggy canyons and sagebrush shrubland of Idaho. This area has been set aside as the Birds of Prey National Conservation Area, lining 81 miles of the Snake River and covering 485,000 acres. Prior to its protection, this land was in the process of being converted to agriculture. The birds of prey had begun a steep decline from shooting and loss of habitat. Conservationists faced strong opposition to the plan, but overcame it, establishing this area in 1971, a year prior to the inclusion of birds of prey on the Migratory Bird Treat Act. It has since become a leading ecotourism destination for rafters and hikers, who are led on tours by naturalists from the Bureau of Land Management (BLM), which oversees the refuge. Fourteen species of raptors breed in the area or migrate through it, and the breeding population of hawks, eagles, owls and falcons has been estimated at 800 pairs. They provide exciting views of high-speed hunting of ground squirrels and birds, and their eerie shrieks resound through the canyons.

Waterfowl hunting is regulated by the Migratory Bird Treaty Act under regulations by the Fish and Wildlife Service. Unfortunately, the regulations have serious shortcomings that have resulted in many shootings of birds of prey. First, hunting can begin before dawn, when hunters are unable to identify birds by species. Each year, hundreds of birds of prey, including such endangered species as Peregrine Falcons, are shot accidentally. Second, the regulations do not

require that hunters be able to identify birds by species, including protected and endangered species. Since many ducks and geese are extremely difficult to identify, the failure of the Fish and Wildlife Service to require hunters to pass identification tests and begin hunting well after daybreak means that protected and endangered birds will continue to be shot.

In October, 1995, a Peregrine Falcon (*Falco peregrinus*) shot in Massachusetts was migrating south from Canada or Greenland during hunting season. It suffered neurological damage after being shot in the left wing while it was flying in a wildlife refuge area. The Assistant Director of the State Division of Fisheries and Wildlife, Tom French, stated that it appeared that the bird was not shot accidentally. This was the second shooting of a Peregrine Falcon in as many years. The reintroduction of captive-bred specimens of these birds into the eastern United States has been a success, with over 130 nesting pairs. Their long-term survival, however, will depend on adherence to laws prohibiting shooting or harming them.

For the future, the Migratory Bird Treaty Act would be far more effective if signed with Latin American and Caribbean nations to protect North American birds wintering in those countries. This would be especially important in view of the decline in many of the continent's birds of prey, which are persecuted and killed by pesticides and poisons in their wintering grounds.

The California Condor (*Gymnogyps californianus*), North America's largest bird of prey, once soared over most of the continent. Its bones have been found among Florida's Pleistocene fossils, and 20,000 years ago, it was very common and widespread, feeding on the carrion of mastodons, bison and other large mammals. This giant bird's superb aerodynamic flight makes the most sophisticated man-made aircraft look clumsy by comparison. Condors have a positive role to play in ecosystems, feeding on carcasses and thereby ridding the environment of these potentially infectious contaminants. Although they declined in range over the centuries, condors were still widespread from Baja California, Mexico, north to Washington state, where Lewis and Clark saw them along the Columbia River in the early 19th century. They were often observed scavenging seal and whale carcasses along the California coast, and they nested as far east as the Sierra Nevada Mountains.

Settlers looked on condors as large targets, with their 10-foot wing span, and perhaps thought they were predatory birds. Hundreds were shot. These birds feed exclusively on carrion and do not hunt live animals. When word spread in the last years of the 19th century that the condors were approaching extinction, egg and specimen collectors preyed on the remaining birds. Between 1881 and 1910, 288 birds were killed as museum specimens (ICBP 1981). By the turn of the century, only a few hundred birds remained, yet killing was still legal. The ornithological journal *The Condor* began publication at this time and recorded many instances of these killings. In one case, an individual named Frank S. Daggett reported shooting a California Condor in 1901, wounding it in the wing and then, when it fell to the ground, shooting it three more times, still not killing it. Finally he clubbed it and shot it yet again before the bird died (Daggett 1901).

The California Condor continued its decline until only 60 birds remained in 1939 (Greenway 1967). The last population survived in a wilderness area of southern California. In spite of legal protection and the establishment of the Sespe Condor Refuge, the birds suffered high mortality from shooting, ingestion of lead shot from deer killed by hunters, feeding on animals killed by predator poisons, collisions with power lines, and accidental capture in leghold traps. Biologists from the Fish and Wildlife Service and the National Audubon Society were assigned to study and protect this small population in the 1960s and 1970s, but they did not publicize its precipitous decline or insist on further protection from the threats that continued to kill these birds. As these birds headed toward imminent extinction, nothing was done to stop deer hunting in their refuge, nor to prevent the use of steel jaw leghold traps or predator poisons in their diminishing range.

One of the last nests was in a regal setting befitting this massive bird: a huge natural hole in a giant, old Sequoia tree. The eggs from this nest and others were taken by the Fish and Wildlife Service for captive hatching. In 1980, one of the last wild chicks hatched in a cave and was being weighed and tested by biologists when it suddenly died. It had

been handled for more than an hour, during which time it repeatedly hissed and jabbed at the researcher. Later it was revealed that shock caused its death. The incident was filmed and shown on national television, resulting in the cancellation of the recovery program by the state of California, followed by a long period of re-evaluation and controversy. By 1981, the state reached an agreement with the Fish and Wildlife Service to allow capture of the last nine California Condors, but the program was delayed by lawsuits and wrangling over details. By the time it was finally decided to capture all remaining condors in 1987, only six survived (BI 2000).

The sad decision to remove all wild California Condors turned out to be the correct path to preserve the species, since its wide-ranging behavior exposed it to countless perils that were beyond the control of its protectors. To the amazement of many, the captive-breeding program succeeded beyond all expectations. The eggs laid by the captive condors were artificially incubated, and chicks were fed by workers, with puppets resembling adult condors covering their hands. So many birds were captive-bred at special facilities run by the Los Angeles Zoo and other breeding centers that by 1992, a reintroduction program began with release of captive-bred birds into the wild in southern California. Some of the released birds died after striking electric power wires or were injured and had to be returned to captivity. Several landed in suburban locations, perching on the decks and roofs of private homes and even, in one case, entering someone's home. Most residents did not recognize the birds™ great rarity and protected status, and put out food, such as hot dogs, for them. Finally, wildlife authorities and television news stations learned about the situation, and many Californians became aware of these giant and extremely rare birds. To many ornithologists, the behavior of these young condors indicated that the birds were tame and considered humans a source of food. The puppets apparently had not fooled them into thinking they were being fed by parent birds.

By July 1994, California Condors numbered 89 birds, 85 of which were in captive-breeding facilities, and four released birds (Collar *et al*. 1994). Six young condors were released in the Grand Canyon area in late 1996, with Fish and Wildlife Service personnel staying close to provide food and to radio-track the birds. Within a short time, one of the condors was killed by an eagle, an unexpected setback. The total California Condor population grew to 120 birds by early 1997, and only a year later it had increased to 147 birds, of which there were 97 in captivity, 28 returned to the wild in California's Los Padres National Forest, and 22 released in Arizona (BI 2000). The released birds are provided with livestock carcasses until they are able to find food on their own. The success of this program has not yet been proven by breeding in the wild, as all released birds are too young. Only time will tell whether these birds survive and reach the goal of 150 birds in separate populations. They are being trained to avoid some of the sources of mortality that killed them in the past, such as power lines, but as long as lead shot is used in deer hunting in their range, this will remain a potential threat to them.

Elsewhere in the world, birds of prey receive little or no protection from persecution. In Italy, shooting of migrating birds of prey has long been a "sport" in which gunners position themselves in concrete bunkers on hillsides and kill hawks, falcons and eagles as they fly by. One woman decided to fight the hunters and worked successfully for an official ban on shooting these birds. In spite of this, illegal shooting takes place in Italy, and every year during the migration season, conservationists from many parts of Europe come to help her enforce the ban. The campaign to stop hunting of these birds was described in a film, fiAnna and the Honey-Buzzardsfl (see Video section). In Australia, persecution of eagles and hawks is rampant. After shooting these birds, especially Wedge-tailed Eagles, they are often nailed to fence posts with their wings spread. Few of the ranchers who kill thousands of these birds seem aware of the important role they play in controlling rabbits.

Snakes

The prejudice against snakes may be traced in some cultures to the Biblical story of Adam and Eve, in which the snake represents the evil temptor. For many, snakes inspire great fear and loathing, and they are often killed upon sight. In the American West, rattlesnake hunts are carried out in many towns as an annual event, with thousands of

snakes captured. After being prodded and manhandled, they are killed, often by being skinned alive. The New Mexican Ridge-nosed Rattlesnake (*Crotalus willardi obscurus*) is a threatened species on the US Endangered Species Act, persecuted and overcollected in its limited range. In Eastern states, especially in the South, snakes are also hunted for sport, burned alive with gasoline poured down their dens, and killed in bizarre religious ceremonies. One town in Georgia has an annual war on rattlesnakes, killing as many as possible. For some species, this has resulted in serious declines. The Eastern Timber Rattlesnake (*Crotalus horridus*), the largest snake native to the United States, inhabits forested areas with rock faces, crevices and caves in the Northeast. It has become threatened in many parts of its range. These snakes, which range in size from 35 to 74 inches in length, are vulnerable to persecution because they congregate in large numbers in rocky dens and overwinter with other types of snakes for warmth. They hide under rocks where hunters and collectors find them. Timber Rattlesnakes are long-lived, known to survive 30 years or more. Females give birth only every other year, do not mature until age 4 or 5, and have only 5 to 17 young (Behler and King 1979). With such slow reproduction, they are vulnerable to declines when hunted.

This species has legal protection from hunting in Pennsylvania and New York and is listed on their state endangered laws, yet hunting still kills hundreds each year. One rattlesnake hunter, profiled by CNN, bragged that he had captured 9,000 Timber Rattlesnakes in his lifetime and planned to continue openly flouting laws protecting the species. He claimed that he enjoyed catching and killing these snakes so much that he would never stop, and some herpetologists accuse this man of single-handedly causing declines. He has been arrested many times and jailed for trading in endangered species, but refuses to stop. These snakes do not pose a threat to people unless they are sought out in their retreats.

Biologists point out that snakes are extremely useful ecologically, feeding on squirrels, mice, rats and other rodents, but since laws in the United States and around the world either fail to protect snakes or are not enforced, snakes often are persecuted and killed senselessly.

Rodent Control

Prior to settlement of North America, prairie dogs of many species inhabited towns of burrows that covered some 98 million acres of shortgrass prairies, from southern Canada to Mexico. One prairie dog town in the Texas Panhandle stretched over 25,000 square miles and held an estimated 400 million animals (Dold 1998). Prior to the 19th century, they are thought to have numbered 5 billion animals (DeBlieu 1993). These towns have since been destroyed, the prairie dogs killed, and the habitat used for agriculture, pastureland and development. A keystone species, prairie dogs create habitat for hundreds of other animals who live in their complex burrow systems. These rodents have been driven to endangered status after centuries of persecution and poison campaigns that were based on the belief by cattle ranchers that prairie dogs ate too much grass, depriving cattle of fodder. The US government sponsored the destruction of prairie dog towns beginning in 1900. The poisoning program was bolstered by inaccurate information from the US Biological Survey, which stated in 1902 that prairie dogs decreased productivity of grasslands by 50 to 75 percent (Dold 1998). Poison bait was distributed in the towns, gasoline was poured into their burrows and set afire, and they were shot by the thousands. A highly toxic poison, 1080, was used from the 1960s on, devastating prairie dog towns and killing vast numbers of animals, from foxes to Golden Eagles, who fed on the poisoned prairie dogs. This reduced prairie dog habitat to about 1.5 million acres, a fraction of their original range.

Modern biological research has unveiled the truth about the effect of these rodents on grasslands. Rich Reading, Director of Conservation Biology at the Denver Zoological Foundation, stated flatly that the Biological Survey's figures claiming that prairie dogs reduced grass by up to 75 percent, were "vastly in error" (Dold 1998). Studies by Dan Uresk, a Forest Service biologist, have concluded that prairie dogs eat only a small percentage of grass--from 4 to 7 percent (Dold 1998). James Detling of Colorado State University in Fort Collins has found that prairie dogs are natural fertilizers, whose incessant grass clipping increases the protein content and digestibility of grass (Long 1998).

Other studies have examined the claims of cattle ranchers against prairie dogs and have demonstrated again and again that these rodents actually improve forage quality for livestock and, by cropping the shortgrass prairie, stimulate it to grow, increasing the amount of grasses around the towns (Wuerthner 1996). The American Bison prospered in herds of 50 million, much of the species range lying within prairie dog towns of the short-grass prairies. Their major predator, the highly endangered Black-footed Ferret (*Mustela nigripes*), has been eliminated in the wild as a result of poisoning and shooting campaigns. At least 130 grassland species are associated with prairie dog towns (Godbey and Biggins 1994), and up to 170 vertebrate species have been seen in these towns.

Another complaint of cattlemen, that cattle fall into prairie dog burrows and break their legs, has also been refuted. Don Sharps, a wildlife consultant, asked an audience of 200 ranchers if any of them knew of a case of a horse or cow that had broken its leg in a prairie dog town, and no one said yes (Dold 1998). Such prejudices are passed down from generation to generation and fuel the persecution programs against these ecologically important rodents.

Slow-acting poisons, such as zinc phosphide, are used by many animal damage control programs. This chemical takes up to 12 hours to kill prairie dogs, who suffer extremely painful deaths (Wuerthner 1996). Another technique is the placement of gas cartridges in prairie dog burrows. These are ignited and burn the prairie dogs alive (Wuerthner 1996). On federal lands, these programs are conducted by the Wildlife Services unit of the Department of Agriculture at public expense. In the 1980s, more than $6 million was spent to eradicate 460,000 acres of dog towns on the Pine Ridge Indian Reservation in South Dakota (Line 1997). This was the largest remaining prairie dog town in the United States (Dold 1998) and the site of the only population of Black-footed Ferrets known to exist in the 1970s. In 1993, Animal Damage Control (now called fiWildlife Servicesfl) used, sold or distributed 220,000 fumitoxin tablets, 60,000 gas cartridges, and 21,000 pounds of zinc phosphate baits in the northern plains states to eradicate prairie dogs (Wuerthner 1996).

Studies about prairie dogs have revealed them to be surprisingly intelligent. They communicate in yips and chirps, some of which are warnings to other members of the town. A study by Professor Con Slobodchikoff of Northern Arizona University has revealed that prairie dogs™ calls convey specific information, such as what size a predator is, what type of animal, its speed of travel and level of threat (Dold 1998). Slobodchikoff created experiments in which two people walked through a prairie dog town that had experienced hunting; one carried a simulated rifle, while the other did not. The prairie dogs gave different calls for each person, and when the "hunter" returned in a few weeks without his rifle, they still gave the call for a man carrying a rifle (Dold 1998). Such communication goes far beyond what most people consider rodents to be capable of and shows their ability to react to a variety of threats, including the most serious one, human beings. Unfortunately, their warnings could not protect them from poison, shooting, and even bulldozing of their burrows.

Knowledge about the true role that prairie dogs play in grassland ecosystems has yet to reach most ranchers and others who have a hatred for these rodents that seems to reach no bounds. Many compare notes on how many prairie dogs they have killed, usually by high-powered bullets that cause them to disintegrate on contact (Long 1998). One group in eastern Colorado with 30 members calls themselves the Varmint Militia and kills prairie dogs as a sport. They recently spent two full days shooting prairie dogs until activity in the prairie dog town slowed (Long 1998). One militiaman bragged of having shot 20,000 prairie dogs and wants to retire from his exterminating business to shoot them full time (Long 1998). These shooters recount with glee the story of a recent protest. Some animal rights protesters tried to stop one of these hunts and chained themselves together, refusing to move; the Varmint Militia called the Kit Carson County sheriff, who placed them in jail for the weekend (Long 1998).

Although private shooting may be difficult to stop, many biologists and conservationists have recommended that all government poisoning and shooting on public land be halted and that subsidies be offered to ranchers who do not kill prairie dogs on their property (DeBlieu 1993). Unfortunately, no action has been taken in this direction.

Sport hunting of these rodents is encouraged by state game departments, and many towns organize hunts as a form of recreation. These hunts, which often involve the killing of hundreds of prairie dogs in a single afternoon, are taking a

high toll of these declining animals in many areas (Wuerthner 1996). A South Dakota organization, Varmint Hunters Association, brags that its 45,000 members do society a favor by killing prairie dogs. The vice president, Marc Minkin, told a reporter, "I'd like to be able to step out my back door in the morning and take a couple of shots before my morning coffee" (Dold 1998). The organized prairie dog shoots draw "hunters" from around the country; one hunt held in Nucla, Colorado, obliterated an entire town (Dold 1998). This hunt, which involves taking pot shots at prairie dogs emerging from their burrows, which they must do to feed, is totally unsportsmanlike--a virtual slaughter.

Even in national parks, poisoning takes place as a result of pressure from neighboring ranchers. In spite of abundant habitat in Theodore Roosevelt National Park, Badlands National Park, Wind Cave National Park and various national monuments in the Great Plains, only 6,000 acres of prairie dog towns have been protected (Wuerthner 1996). In most cases, park authorities have been threatened with lawsuits unless they poison prairie dogs. In South Dakota, home of Badlands National Park, a prime potential area for reintroduction of the endangered Black-footed Ferret, the state has declared prairie dogs to be noxious pests and mandates their control (Long 1998). At Devils Tower National Monument in Wyoming, the park rangers use rifles and poison to thin the ranks of its prairie dog colony (Long 1998).

Increasingly, development in the form of housing complexes, malls, highways and industrial centers, has gobbled up millions of acres of land in the West, much of it inhabited by prairie dogs. Some developers merely bulldoze the towns, while others pay to have a company use a giant vacuum cleaner that sucks prairie dogs out of the ground amid deafening noise similar to that of a jet airplane taking off. The proud inventor of this machine bragged that it was non-lethal, and the rodents could then be killed humanely or otherwise disposed of to allow development programs to proceed. In fact, most of the prairie dogs taken in this manner are killed or injured in the process (Dold 1998). The trauma involved for the prairie dogs must be extreme. Many of the prairie dogs removed from their burrows have been offered for sale as pets, advertised in eastern newspapers. Although loveable and cute, these animals are not suitable house pets because they are wild rodents who require extensive dirt to burrow in. They cannot adjust to the unnatural environment of a home. Unfortunately, this new invention has been given favorable publicity in the media. The majority of prairie dogs that survive this operation end up as pet food, according to CNN (December 15, 1996).

A more humane program involves the moving of prairie dogs to safer environments. A Colorado organization, Prairie Ecosystem Conservation Alliance, hoses prairie dog burrows with water and a biodegradable dish soap that creates frothy suds below ground. The suds irritate the eyes of the prairie dogs, who come to the surface where members of the Alliance are waiting to scoop them up and place them in carriers. They then truck them to a safe area, preferably one with empty burrows, and release them (Dold 1998). An even better solution is to save the towns, since the latter method will not save all the other animals inhabiting the burrows. The city of Boulder, Colorado, became the first town in the state to officially designate land to protect prairie dogs. In 1987 it set aside a preserve for prairie dogs, which now covers almost 5,000 acres (Dold 1998). Fort Collins, further north, began with a reserve of 268 acres and now has 1,700 acres (Dold 1998).

A Native American Gros Ventre tribesman, Mike Fox, has come full circle, from sponsoring prairie dog shoots on the Fort Belknap Indian Reservation in Montana to understanding their positive effect on grasslands by watching Bison graze near the towns on the "best grass around" (Long 1998). There are 400 American Bison on the reservation, and Fox, who manages the reservation's wildlife program, has sharply curtailed prairie dog shooting and accepted 23 Black-footed Ferrets to be reintroduced into the 500,000 acres of prairie on the reservation (Long 1998). He tells Indian ranchers, who still kill prairie dogs, that these animals were here before, and the ferret is not a new animal, but an old one returning (Long 1998).

All but 2 percent of original prairie dog populations are now gone, having been poisoned out to make way for livestock or agriculture. The majority of remaining towns are still unprotected, and the poisoning continues. Grasslands with prairie dogs support far higher densities of mammals, birds and other wildlife than those without them.

Several prairie dog species have been driven to near extinction. The Utah Prairie Dog (*Cynomys parvidens*), native to

south-central Utah, became endangered from these programs and the loss of habitat to livestock and agriculture. Listed on the US Endangered Species Act, this species has a restricted range in southwest Utah, and after poisoning programs, its population fell from an estimated 95,000 animals in 1920 to only 3,300 in 1972 (Nowak 1999). Through protection accorded by the US Endangered Species Act, Utah Prairie Dogs began to rebound, and by 1984, the species was downgraded from Endangered to Threatened on the US Endangered Species Act. Populations of prairie dogs fluctuate widely, and counts of Utah Prairie Dogs in the early 1990s ranged from 6,400 in the fall to 24,000 after they had pups in the spring (Nowak 1999). The species has recovered somewhat overall, mainly as a result of the Fish and Wildlife Service program of transplanting prairie dogs from private to public lands (Turbak 1993). Initially, many of the released prairie dogs failed to survive, and not until they began releasing males in the spring, who industriously spent the summer excavating burrows to accommodate other prairie dogs released in the fall, did transplants succeed (Turbak 1993). Utah Prairie Dogs hibernate each winter in compartments in the complex maze of their underground tunnels.

Although some Utah Prairie Dogs have been placed on public land, 60 percent of them still live on private land, where special US Endangered Species Act regulations allow farmers and ranchers to shoot or trap an annual quota of prairie dogs; a high of 6,000 were killed one year, and in 1992, 1,543 were killed (Turbak 1993). Education campaigns and tax incentives to protect prairie dog towns would be far preferable to quota systems.

Mexican Prairie Dogs (*Cynomys mexicanus*) of southern Coahuila and northern San Luis Potos, Mexico, have declined as their habitat has been converted to agriculture and grazing land for livestock, and many colonies were exterminated by poisoning. The largest remaining town covers only 4,400 hectares (Nowak 1999). The species is listed as Endangered by the US Endangered Species Act as well as by the *2000 IUCN Red List of Threatened Species*.

A third species, the Black-tailed Prairie Dog (*Cynomys ludovicianus*) has declined by 98 to 99 percent (Wuerthner 1996) in a range which once extended from Montana and southern Saskatchewan to northern Mexico (Nowak 1999). The Biodiversity Legal Foundation in Colorado filed a petition in October 1994 to list it as a Category 2 species under the US Endangered Species Act, a category just below Threatened. Although the Fish and Wildlife Service's own biologists supported this listing, the petition was denied after political pressure from ranchers (Wuerthner 1996).

Thus, at least three of North America's five species of prairie dogs are in grave danger of extinction, and the remaining two have declined precipitously. Their ecosystems are threatened as well, as are many of the species that depend on them. Although they are extremely photogenic and likeable, prairie dogs are not ecotourist attractions at present. With protection and more publicity, such as nature films and education programs, they could become so, and this would enhance their conservation.

Conservationists have proposed some huge reserves for prairie dogs that would link remnant populations in parts of the West, where much of the land is now under the control of the Bureau of Land Management of the Department of the Interior. The latter department favors cattle ranchers more than prairie dogs, but with outside pressure and publicity, such a plan might become reality. The Fish and Wildlife Service has had difficulty locating prairie dog towns that are protected from poison programs in which to reintroduce captive-bred Black-footed Ferrets.

For their long-term survival, prairie dogs need extremely large territories. At present, fragmented populations, which are often reduced to a few hundred animals widely separated from the nearest prairie dog town, have lost viability from lack of genetic interchange, and some scientists fear that their natural behavior may be altered by this isolation. These loveable animals need more friends to speak out on their behalf and demand that they be protected from poisoning, "sport" hunting and other persecutions, and that sanctuaries be established.

Economically, they may be worth far more alive than dead. The potential for using prairie dogs as a focal point for ecotourism is great. Tourists would be delighted by their behavior and fascinated to see the rich wildlife that inhabits their towns.

Trophy and Sport Hunting
During the late 19th and early 20th centuries, wealthy European and American big game hunters traveled to Asia, Africa and South America to "bag" large animals that they proudly displayed as stuffed animals and heads mounted on the walls of their homes. Maharajahs of India and British hunters took what Vincenz Ziswiler (1967), in his interesting book, *Extinct and Vanishing Animals*, describes as "a morbid pleasure in killing." Lord Ripon, an Englishman who died in 1923, was credited with killing 500,000 game birds and mammals--about 67 creatures for every shooting day of his life (McClung 1976).

One maharajah turned away from hunting and became a famous conservationist. Brajendra Singh, the last Maharajah of Bharatpur, hosted hundreds of hunts on his estate at the Keolada Ghana marsh 100 miles south of Delhi. A shoot organized by an English lord resulted in the killing of 4,323 ducks by 39 hunters in one day. In 1970, Brajendra Singh converted the duck shoot marsh into India's best known bird sanctuary. Singh died in 1995, having presided over the preservation of this vast marsh and its rare resident birds.

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Trophy and Sport Hunting: Page 1
The most prestigious trophy for maharajahs and colonial hunters was the Tiger (*Panthera tigris*), largest of all cats. One maharajah shot at least 1,000 Tigers in his lifetime, while another complained that his total bag of Tigers was only 1,150 (McClung 1976). The number of Tigers killed by these two maharajahs equaled the entire population of these cats in India by the late 1960s. Tiger hunts were a royal pastime and employed hundreds of native "beaters," who drove the frightened cat toward a hunter who was perched safely atop an elephant.

Tigers require large territories. Even in the best habitats, their natural density is low. They probably once numbered 50,000 in India alone, however, when forests covered much of the country. Tigers were hunted to extinction on the Indonesian islands of Java and Bali, where each was a separate subspecies, and they have been hunted to endangered status on Sumatra. In the western portion of their range, the Anatolian or Caspian Tiger (*Panthera tigris virgata*) once ranged from Turkey eastward through the Caspian Sea region of Central Asia. Hunting eliminated these Tigers in Central Asia centuries ago, and only a few isolated populations remained in Turkey by 1900. The last individuals in Turkey were shot in 1972. This subspecies was driven to extinction by trophy hunting and persecution by livestock owners. By the 1960s, Indian Tigers were endangered, yet trophy hunting and killing by livestock herders for the fur trade continued. Indian President Indira Ghandi established a conservation program called Project Tiger in the 1970s, which set aside many reserves and accorded strong legal protection. When the species was beginning to increase in numbers, a trade in their body parts for Traditional Chinese Medicine reversed this recovery.

Today, fewer than 5,000 Tigers remain in the wild. At the present rate of killing--one Tiger per day--the species will become extinct in the wild within 30 years or less. Hunting of these magnificent cats intensified in the 1980s and has accelerated everywhere. They are killed by poison, traps and guns wherever they survive. Villagers and professional

hunters sell Tiger pelts, bones and other body parts in a network of smugglers that reaches from rural India, Bangladesh and Indochina to China, Japan and Taiwan. Tiger pelts are openly sold as trophies in many Asian countries, including Pakistan, Cambodia and Vietnam. They are displayed on shop walls, often with head attached. Some Tiger cubs are even part of this trade, killed and stuffed to be sold as tiny curios.

This magnificent cat will not survive long without legions of rangers guarding the remaining animals. Anti-poaching funding is inadequate in almost all its range. Indian parks and sanctuaries, many of them set aside for the Tiger, are understaffed, and dedicated wildlife wardens are underpaid and poorly equipped to combat poachers (Currey 1996). Some Indian park wardens have been bribed by poachers and watch as they skin dead Tigers (Breeden and Wright 1996). Elsewhere in the Tiger's range in Thailand, Cambodia and Burma, for example, few parks and protected areas have been set aside, and wildlife conservation has low priority.

The market for the pelts and stuffed trophies of these last Tigers among wealthy status-seekers in Asia and elsewhere has increased in recent years. One Taiwanese businessman profiled in a *National Geographic* article (Zich 1993) proudly displayed three stuffed Tigers which he had placed in his bedroom; one of the Tigers was standing on a Lion pelt with the head attached. He protested, "I worked so hard to make money. Now I spend it" (Zich 1993).

In spite of what appear to be overwhelming odds, new projects are attempting to turn the tide. Anti-poaching work in Siberia has helped arrest the steep decline of this critically endangered race of the Tiger in a joint United States-Russian program (Galster 1996). An international fund begun by Exxon Corporation, whose logo is a Tiger, has sponsored anti-poaching work and research throughout its range as well as education programs to persuade Asians not to purchase Tiger products. The US Congress appropriated several million dollars for anti-poaching campaigns, and organizations, such as the Wildlife Conservation Society based in New York City, have worked in Cambodia, Indonesia and other countries to survey and aid in conservation of the species. Scientists have cooperated in studies of the Tiger and aided governments in conservation programs, as described in the recent book, *Riding the Tiger. Tiger Conservation in Human-dominated Landscapes* (Seidensticker *et al*. 1999).

The Asiatic Cheetah (*Acinonyx jubatus venaticus*) once occurred throughout the Middle East as far as India. In the 16th century, the Indian emperor Akbar the Great kept more than 1,000 Cheetahs for hunting. Only one litter was produced by his Cheetahs, and the species died out in India and all of its Asian range except Iran, where fewer then 200 animals remain (Hunter 1998). It is classified as Critical, the most endangered category by the *2000 IUCN Red List of Threatened Species*. The Northwest African Cheetah (*Acinonys jubatus hecki*) is listed as Endangered by the IUCN. In reality, it is nearly extinct, with possible survival only in Algeria, Morocco and Niger, having disappeared from Egypt, Libya and Western Sahara. In the Saharan region, nomadic tribes, such as the Tuareg and Toubou, hunt Cheetah in desert areas of Mali, Niger and Chad, using saluki dogs (Hunter 1998). On occasion, Cheetah prey on young camels in the area, their natural prey having been eliminated. The tribes have such a hatred for Cheetah that they pursue them if they see their tracks, with or without proof of predation (Hunter 1998). Being followed for days in the extreme heat, the Cheetahs sometimes die from heat and stress even before the men and dogs reach them (Hunter 1998).

Trophy and Sport Hunting: Page 2

In the stark deserts of the Saudi Arabian Peninsula and the Mideast, wildlife is not abundant. Animals struggle just to survive in the harsh environment. A wild desert equine became a casualty of unrestricted hunting after World War I. The Syrian Wild Ass (*Equus hemionus hemippus*) was hunted to extinction for sport and meat. These wild asses had been hunted out of most of their original range by the 19th century, but in 1850, they were still seen commonly in large herds in the region once known as Mesopotamia, between the Tigris and Euphrates Rivers. Perfectly adapted to the searing desert heat and sparse vegetation, they ran from natural predators at great speed, and their sand-brown

coloration camouflaged them. After thousands of years of adaptation and survival, these delicately hued wild asses found themselves shot at by 20th century soldiers and other hunters. World War I troops and later, civilians in all-terrain vehicles, chased them at high speeds, killing entire herds of these equines for "sport." With no natural cover and unable to outrun jeeps, entire herds were slaughtered. The last known Syrian Wild Ass was shot in 1927 as it came down for water at the Al Ghams oasis in northern Arabia (Day 1981). The surviving populations of this species, the Asian Wild Ass (*Equus hemionus*), are listed as Endangered by the US Endangered Species Act.

After World War II, Arab sheikhs began hunting Arabian Oryx (*Oryx leucoryx*), Arabian Gazelles (*Gazella arabica*) and Arabian Ostrich (*Struthio camelus syriacus*) in all-terrain vehicles and trucks, mowing them down with repeating rifles, shotguns and even machine guns. These macabre and senseless hunts even involved the use of planes and helicopters for spotting. Sometimes animals were pursued until they dropped dead from exhaustion. In 1955, some 482 cars took part in a hunt during the course of a "royal goodwill tour" in northern Saudi Arabia, and every living animal seen was gunned down (McClung 1976). The Arabian Ostrich formerly ranged from Syria to the Arabian Peninsula, and it became a casualty of these forays. The last wild Ostrich was killed and eaten by Arabs near the Trans-Arab oil pipeline north of Bahrain between 1940 and 1945 (Greenway 1967).

The Arabian Oryx nearly followed the Ostrich into extinction when the last three individuals left in the wild were killed off in 1972 in southern Oman (IUCN 1978). This statuesque white antelope, with long, curved horns that arch over its back, once inhabited a wide range in the Middle East, from Syria and Israel to the Arabian Peninsula (Nowak 1999). It was saved from extinction by actions of the Fauna Preservation Society, headquartered in England, and the IUCN, which had undertaken an expedition in 1962 to capture some of the last wild Arabian Oryx for captive breeding. In eastern Aden, four oryx had been taken into captivity, and this herd was augmented from private game farms and zoos by another eight animals, which were transported to the Phoenix Zoo in Arizona. They adjusted easily to the desert climate of the American Southwest and soon bred in captivity. This herd has grown, and several zoos now breed them. Some of these stately animals have been reintroduced successfully into preserves in Oman and other parts of their original range. They have been studied by field biologists who have found that they reverted to wild behavior, with females in separate herds, and males solitary or in bachelor herds defending territories (Nowak 1999). Eighteen breeding herds occupied 14,121 square kilometers in Oman in two 1988 studies (Nowak 1999). In 1990, more Arabian Oryx were reintroduced into Saudi Arabia. There are now about 500 of these oryx in the wild and an additional 300 in captivity on the Arabian peninsula; 2,000 are held in zoos (Nowak 1999). For many Arab conservationists, the return of the Arabian Oryx has been an important event because this species has been very important to the cultures of the Arabian Peninsula for thousands of years. The reintroduced oryx have been guarded zealously to prevent another tragic disappearance.

Gazelles of dryland and open country were at one time abundant throughout North Africa and the Middle East, able to survive in the hottest and dryest of deserts. People have long hunted them for food, and there is little cover where they can hide. In ancient times, stone corrals were constructed into which gazelles were driven for slaughter, and until the early 20th century, these were still in use (Nowak 1999). Some Arab hunters still use captive and trained falcons to harass gazelles in order to frighten and confuse them so they can then be chased down by dogs (Nowak 1999). Two of these small and dainty ungulates have been hunted to extinction, and others have become very rare throughout the region. The Antelope Specialist Group of the IUCN lists the Saudi Gazelle (*Gazella saudiya*) as extinct in the wild and the Queen of Sheba's Gazelle (*Gazella bilkis*) of Saudi Arabia as extinct, with no captive populations. Until the 1990s, the latter species had been classified as Endangered. But the *2000 IUCN Red List of Threatened Species* reports that this delicate animal, which was considered very common in 1951, has not been seen in decades. A survey in 1992 in its range in mountains near Ta'izz failed to find any of these gazelles.

The *2000 IUCN Red List of Threatened Species* categorizes many other gazelles of the region as Threatened and Endangered. The Arabian Gazelle (*Gazella gazella*), native to the Arabian Peninsula, Israel and Palestine, is classified as Conservation Dependent, a category indicating that without strict protection it would decline to Threatened status. Five subspecies of this gazelle are listed in various categories, the most endangered being the Palestine Mountain Gazelle (*Gazella gazella gazella*) (Conservation Dependent) and the Acacia Gazelle (*Gazella gazella acaciae*)

(Critical) of Israel, and the Muscat Gazelle (*Gazella gazella muscatensis*) (Critical) of Oman. Another threatened gazelle is the Arabian Sand Gazelle (*Gazella subgutturosa marica*) (Vulnerable). These little Mideastern gazelles have been heavily persecuted and hunted. Added to the hunting, which is not well controlled, the Arabian Peninsula and much of Israel and Palestine have been heavily overgrazed by livestock, and the scarce oases are used for agriculture and livestock, leaving little natural vegetation for wildlife.

Reintroduced gazelles in Israel's Golan Heights increased to about 4,000 in the late 1980s, and government officials decided to allow the hunting of 2,000 of them by Arabs, who shot to wound rather than kill so that the animals could be killed ritually through throat slitting. This hunt, filmed by Afikim Productions and Survival Anglia in 1990, was a gruesome sight of crippled and dazed gazelles, stumbling about after the shooting.

The most avidly pursued animal by Arab sheikhs is undoubtedly the Houbara Bustard (*Chlamydotis undulata*). The meat of this large, long-legged bird of scrubby desert and sandy grasslands is considered an aphrodisiac by Arabs, although in fact it is a mild diuretic (Weaver 1992). It has been hunted relentlessly on the Arabian Peninsula, causing many populations to disappear. Arab sheikhs have hunted these birds for centuries using a trained falcon that catches the bird as it flies to escape. The great oil wealth accumulated by sheikhs of Saudi Arabia, Qatar, Bahrain, Kuwait and the United Arab Emirates has allowed them to indulge in this "sport" in a manner befitting the bejeweled and pampered rulers of ancient kingdoms. With these bustards so rare on the Arabian Peninsula, they now hunt them in Pakistan. Traditionally, the sheikhs used camels as transport, but today they drive in fleets of 60 or 70 customized all-terrain vehicles, careening through the desert at speeds up to 80 miles per hour, flattening the landscape, vegetation and small animals under their wheels (Weaver 1992). Armed with high-powered guns to shoot any animal that comes into view, the sheikh occupies an elevated seat that swivels 180 degrees to enable him to spot the Houbara Bustards and their tracks in the sand (Weaver 1992). The ecological damage done by the armies of vehicles that flatten vegetation, scar the landscape, and slaughter every animal they see is so severe that it may result in the local extinctions of many rare and delicate species of the Pakistani desert (Hoyo *et al*. 1996).

Many Houbara Bustards winter in Pakistan, converging from breeding areas in Kazakhstan and other countries in the region. Their breeding range extends to North Africa east across Asia to China. In Pakistan and 23 other countries, including India, Iran and Russia, the Houbara Bustard is totally protected from hunting (Weaver 1992). Yet by means of lavish gifts and payments to high government officials and landowners, wealthy Arabs have received special dispensation to pursue and kill thousands of these birds, which are considered endangered and declining in many parts of their range, especially in North Africa, Bahrain, Jordan, Iran, Iraq and India (Hoyo *et al*. 1996, BI 2000).

These extraordinary birds present a spectacular show with their elaborate courtship, strutting and displaying beautiful white puffs of head and body feathers.* Some hunting, mainly illegal, also occurs in their breeding grounds, which greatly disrupts their courtship, nesting and care of chicks.

*"Red Desert," a film in the series fiRealms of the Russian Bearfl described in the Video section, shows these birds displaying and hunting lizards.

The hunts have been carried on for decades in Pakistan, and Houbara Bustards have declined steadily as a result. As early as 1983, scientists and conservationists at a symposium on bustards convened by the International Council for Bird Preservation (now BirdLife International) unanimously called for a five-year ban on hunting (Weaver 1992). Although Pakistan's President at that time supported the symposium, he ignored the appeal and, the following year, allowed 25 parties from the Saudi Arabian Peninsula to hunt; they killed more than 5,000 Houbara Bustards (AWI 1985). Since that time, hunts have continued in spite of changes in administration in Pakistan, and although Arab hunters realize that these birds are heading toward extinction, they have not decreased their kills or practiced conservation. Moreover, they are now hunting in new areas, close to breeding grounds (BI 2000).

One sheikh, the cousin of the ruler of Dubai, found no Houbaras in the tract where he had arranged to hunt. He then moved his camp into Kirthar National Park, where he illegally killed more than 200 Houbaras in 10 days, along with

protected gazelles and ibex (Weaver 1992). As recently as the 1960s, Houbara Bustards were so numerous in Pakistan that they could be counted "like butterflies in a field," but by the 1990s, they became scarce in many areas, and their populations have experienced sharp downward trends (Weaver 1992). No restrictions are placed on the take of Houbaras by the visiting sheikhs.

Some Pakistani conservationists have fought the illegal arrangements made between the Arabs and government officials, and the Society for Conservation and Protection of the Environment (SCOPE), took the issue to the Sind High Court, which ruled in their favor (Weaver 1992). However, because Pakistani government officials rarely follow such provincial court decisions, the hunt did not end. When asked why the government has done so little to protect its wildlife, a well-known Pakistani environmentalist, Wahajuddin Ahmed Kermani, the retired Inspector General of Forests, replied, "Because we lack the moral fibre and the moral courage" (Weaver 1992).

Protests from conservationists in Europe and elsewhere have had no real effect either. Paul Goriup, the bustard expert at BirdLife International in Cambridge, United Kingdom, believes that populations of Houbara Bustards in Sind and Punjab provinces of Pakistan have become "terribly diminished," and hunting of breeding populations has a disastrous effect (Weaver 1992). Goriup contends that the species must be protected by the United Nations' Bonn Convention on Migratory Species to bring the issue to an international level (Weaver 1992). The Houbara Bustard is listed on Appendix I of CITES, which bans all commercial trade between member nations. Yet each year, 500 or more eggs, chicks and adult Houbaras are smuggled from Pakistan, a CITES member, by sheikhs who use them to train their falcons and for captive-breeding programs of dubious effectiveness. Abrar Mirza, the wildlife conservator for the Province of Sind, confiscates many such shipments, but most provincial wildlife officials merely look the other way, especially after receiving diamond-studded, gold Rolex watches and other such gifts from the Arabs (Weaver 1992). The confiscation of so many Appendix I birds in the United States would result in severe penalties, including possible jail sentences, but the effectiveness of CITES depends on the legislation each member country enacts to enforce it and the zeal with which these laws are enforced.

Sheikhs from the United Arab Emirates (UAE) were not so well-received in Turkmenistan in 1995 when they applied to the Ministry of Foreign Affairs to hunt Houbara Bustards. This Ministry forwarded the request to the Ministry of Nature Use which, quite unexpectedly, turned it down because the birds would be breeding (Zatoka 1995). Certain that they would be able to overcome this opposition, the sheikhs arrived in Turkmenistan ready to hunt without official approval, bringing their falcons (Zakota 1995). To their amazement, they were issued an official complaint by the Director of the Department for Animal Conservation and fined $40,000 (Zakota 1995). The sheikhs then turned to Turkmenistan's President Niyaziv, confident that they would be able to overturn the decisions of the wildlife department; instead, he backed up the decision of the Ministry of Nature Use, stating that it had jurisdiction in this issue (Zakota 1995). This was an extremely important precedent and a fine example of a country according its wildlife the respect and protection it deserves. Turkmenistan has a record of combating poaching and conducting environmental research and conservation programs (Zakota 1995).

One sheikh has renounced hunting and fostered environmental programs. Sheikh Zayed of the United Arab Emirates, while hunting gazelles with a rifle, realized that this amounted to "an outright attack on animals" and a cause for their possible extinction (Morgan 1998). He then began a program of setting tracts of land aside for wildlife and setting up breeding herds of endangered oryx, gazelles and other desert ungulates on an island off the coast (Morgan 1998). Other UAE sheikhs have obtained special favors when hunting on the African continent. The government of Tanzania granted exclusive hunting rights in one of the country's most important wildlife areas to a high-ranking official from UAE (Alexander 1993). The agreement was reached in secret with the Deputy Minister of Defense of that country, and he apparently has been allowed to hunt endangered species, such as Cheetah, with automatic weapons (Alexander 1993). The influence of wealthy Arabs in bending wildlife laws has reached to many corners of the world. One of their prime targets is North America for its beautiful Gyrfalcons (*Falco rusticolus*), listed on CITES Appendix I, one of the most coveted of all birds of prey for falconry. Their attempts at bribery, often successful, to obtain these protected birds from Canada resulted in the listing of this species on CITES to prevent any further commercialization of these birds, which was causing declines in their wild populations.

Trophy and Sport Hunting: Page 3
The vast Sahara has been the scene of similar hunts. Scimitar-horned Oryx (*Oryx dammah*) originally had a wide range in arid grasslands from Morocco and Senegal east to Egypt and the Sudan. In historic times, herds of 100 animals were commonly seen, and during wet season migrations, they traveled in groups of 1,000 animals or more. Their white and brown coloration allowed them to blend into the desert, and they were admired for their extremely long, back-curving horns. Their populations and range gradually shrank with hunting, overgrazing and agricultural encroachment on natural grasslands; the species disappeared from Egypt and Senegal in the 1850s. In the 1970s there were still an estimated 6,000 of these spectacular animals in the southern Sahara (Nowak 1999). The Haddad tribe of northern Chad centered their way of life around hunting these oryx, driving them into nets and killing them for their meat (Simon 1995).

Although traditional hunting made inroads into Scimitar-horned Oryx populations, the use of four-wheel-drive vehicles and modern firearms by prospectors and military personnel within the past 30 years drove the species to near extinction (Simon 1995). Groups of wealthy Middle Eastern hunters arrived with all-terrain vehicles and automatic rifles, eliminating these animals from most of their range. Chad's Ouadi Rime-Ouadi Achim Faunal Reserve became one of their only refuges by the 1970s, but the outbreak of war between that government's forces and Libyan-backed rebels in 1978 brought about an unregulated slaughter of the last population of Scimitar-horned Oryx within the reserve, reducing them to only a few hundred animals (Simon 1995). In an attempt to reintroduce these majestic antelope to their original range, 41 were captured in western Chad in 1966 and placed in captivity (Simon 1995). Some 500 of these oryx are part of the American Zoo Association's Species Survival Plan, and another 700 are in other zoos; an unknown number are in ranched herds, especially in Texas (Nowak 1999). A small number of Scimitar-horned Oryx were released into a national park in Tunisia in 1991 (Simon 1995), and others may be released in Niger (Nowak 1999). The IUCN listed this species as Critical in 1996, Extinct in Algeria, Egypt, Libya, Mauritania, Senegal, and Western Sahara, and Probably Extinct in Burkina Faso, Chad, Mali, Niger, and Sudan. The *2000 IUCN Red List of Threatened Species* listed the Scimitar-horned Oryx as Extinct in the wild.

The Addax (*Addax nasomaculatus*), a desert antelope which once ranged from Western Sahara and Mauritania to Egypt and Sudan, is now nearly extinct in the wild as a result of heavy hunting combined with loss of its grassland and shrubland habitat to agriculture and competition with livestock. Perfectly adapted to life in the desert, Addax are able to spend their lives without drinking water, deriving moisture from plants on which they feed (Nowak 1999). Instead of the long, arched horns of the Scimitar-horned Oryx, the Addax has horns that grow outward, then bend inward and upward. A stocky antelope that is not able to run quickly enough to flee men on horses, it has been easy prey for hunters and feral dogs. In recent years, remnant populations literally have been run to death by tourists in four-wheel-drive vehicles who pursue them until the animals fall dead in the sand (Nowak 1999). A herd in northeastern Niger was reduced to 50 to 200 animals when, according to some reports, they were wiped out by hunting. Fewer than 200 remained in north-central Chad, and another 50 along the border of Mali and eastern Mauritania in 1994 (Nowak 1999). The *1996 IUCN Red List of Threatened Animals* listed the Addax as Endangered, Extinct in Algeria, Egypt, Libya, and probably Sudan. The *2000 IUCN Red List of Threatened Species* upgraded its status to Critical. A small reintroduced population survives in Tunisia, but the wild population is at risk of disappearing altogether. More than 400 animals are in captivity, including a herd in a large dryland safari park in Texas called Fossil Rim.

Other Saharan animals have been ruthlessly pursued. Pelzeln's Gazelle (*Gazella dorcas pelzelni*) have been pushed to Vulnerable status by hunting. They are listed on the US Endangered Species Act. The Slender-horned Gazelle (*Gazella leptoceros*), native to North Africa, is now endangered throughout its range, according to the *2000 IUCN Red List of Threatened Species*. The hunting of these desert animals by men in all-terrain vehicles, some armed with

machine guns, reached such heights in the 1970s that they nearly became extinct, and their status has not improved in the intervening years. The endangered Dama Gazelle (*Gazella dama*), also a heavily hunted species, is extinct in Algeria, Libya, Mauritania, Morocco and Western Sahara; it has been reintroduced into Senegal, and populations are now confined to Chad, Mali, Niger and Sudan (Baillie and Groombridge 1996). Cuvier's Gazelle (*Gazella cuvieri*), another North African species, is also extinct in the Western Sahara and survives in endangered populations in Algeria, Morocco and Tunisia, according to the IUCN. In some cases, antelope and gazelles have been pursued by hunters in helicopters who shoot at them with rockets, a method also used to kill African Elephants in Chad, where the last Greater Kudus (*Tragelaphus strepsiceros*) were destroyed in 1976 (Anon. 1977).

Trophy and Sport Hunting: Page 4

Poachers have caused the extinction in Somalia of the endangered Hunter's Hartebeest or Hirola (*Damaliscus hunteri*), which now survives only in a restricted portion of scrubby desert of south-eastern Kenya. Looking somewhat like an Impala, this delicate, dryland antelope can live for weeks on very little water. This species is considered an evolutionary relic, having lived on earth for 15 million years, and is a progenitor of other hartebeests and the Topi; fossil evidence indicates that the Hirola's range once extended to South Africa (McKinley 1996). Kenyan populations totaled 14,000 in 1976, living along the Tana River and in the arid Garissa region to the east (McKinley 1996). In the 1980s, poachers killed off the region's African Elephants, who had kept the land clear of thorn bushes for grazers, such as the Hirola (McKinley 1996). A rinderpest epidemic brought in by cattle herders wiped out half the region's antelope between 1983 and 1985.

In the early 1990s, Somali refugees and troops fleeing from civil war in Somalia crossed into Kenya and began slaughtering the Hirola (McKinley 1996). By 1993, only 2,000 Hirola survived, and with unregulated hunting, a 1995 census found a total of 306 animals scattered in small groups over 45,000 square miles (McKinley 1996). Rangers from the Kenya Wildlife Service decided to capture and move as many as possible of the remaining animals to Tsavo National Park, where they could be guarded against illegal hunting. One hundred animals were moved to the park in 1995, and a year later, about 57 survived. In 1996, more were chased by helicopter into nets, sedated, blindfolded, and then taken by truck to a small plane which airlifted them to Tsavo. The habitat in Tsavo is lusher and greener than their native desert shrub, and the Hirola may not thrive there. Only time will tell. The *2000 IUCN Red List of Threatened Species* lists the species as Critical.

Trophy and Sport Hunting: Page 5

In South Africa, the Quagga (*Equus quagga*), a zebra-like equine, became extinct from hunting. Some zoologists consider these animals to have been a race of Burchell's Zebra (*Equus burchelli*), but others classify them as a full species. They had black, vertical stripes on the head and neck, while their back and haunches were uniform grayish or faintly striped. Native to the Cape Colony grassy plains, their limited and open habitat made them vulnerable to the Boer settlers, who killed them by the thousands (Day 1981). Many were tamed and used to guard domestic livestock at night because they gave loud alarm calls upon seeing predators (Day 1981). Some were even shipped to London and used as harness animals. The Boers used their skins for sacks and other practical purposes. By the 1850s, it had nearly disappeared from the Orange River area from relentless hunting (Nowak 1999). The last wild Quagga was killed in 1878, and in 1883, the last captive Quagga died in the Amsterdam Zoo (Day 1981). Photographs (Nowak 1999) and specimen skins exist with DNA that has been compared with living zebras. There has been talk of restoring a Quagga-like animal through selective breeding with Plains Zebras.

Many other South African species were reduced to endangered status or eliminated from the country altogether by

Boer hunting and their policy of clearing the land for livestock and agriculture. Although many parks have been set aside, wildlife as a whole has been crowded out of its natural environments in South Africa. Elephants became restricted to an area in the northeast that later became Kruger National Park, and only recently have they been reintroduced into a few parks elsewhere. Zebras have become extremely rare, with several races critically endangered (see Grasslands, Shrublands and Deserts chapter).

The high-altitude Simien Mountains National Park (6,234 to 14,535 feet) has many endangered endemics. A Survival Anglia film, fiEdge of the Abyss,fl records many of these species, including the Walia Ibex (*Capra walie*), a mountain goat found only in Ethiopia. It has a population of about 300 in the park and stays above 10,000 feet, browsing in the giant heath. These goats were common until the 1930s when hunting decimated their numbers. They also have lost habitat to agriculture and livestock. By the 1960s, there were only 200 Walia Ibex in the park, and although they have recovered somewhat, they still are poached for their magnificent, massive curved horns, hides and meat. Poachers enter the park and place nooses on the narrow mountain trails they must use to travel from one part of the park to another.

Trophy and Sport Hunting: Page 6

Local villagers in Kankani, India, have turned the tables on hunters of the threatened Blackbuck. This town, located in the Rajasthan desert of western India, has a history of preserving nature, refusing to allow an 18th century maharajah to cut their trees by encircling them and vowing to be killed rather than let the maharajah's men cut the trees (Bearak 1998). When hunters in all-terrain vehicles awoke the villagers with gunshots in October 1998, the villagers chased them off and got the license plate number of the driver (Bearak 1998). Some bucks of these striking black-and-white antelope had already been killed. "These animals are considered sacred to us, and we consider their lives more important than even our own," said a village elder of the Bishnoi people (Bearak 1998). The license turned out to belong to a famous movie actor, Salman Khan, star of many high-action, violent films (Bearak 1998). The story was told in many newspapers, and public opinion turned against Khan, who came to symbolize the callous rich who take pleasure in poaching endangered species like the Bengal Tiger and Sarus Crane (Bearak 1998). The week before, he had hunted Chinkara (*Gazella bennetti*), a Conservation Dependent species, according to the IUCN. On October 12, 1998, the actor was arrested, but he was unlikely to go to jail, as a result of his fame and wealth. The village elder said: "Between us and the animals there is complete trust. Our teachings tell us that we must serve as protectors and nurturers of all living things" (Bearak 1998).

Trophy Hunting Clubs

The US-based Boone and Crockett Club keeps records of trophy animals for North American mammals, and Safari Club International (SCI) maintains international records and promotes trophy hunting of animals worldwide. US state wildlife departments tend to favor sport hunting, and many earn large license fees from the trophy hunting of Bighorn Sheep, Elk, Grizzly Bear, Gray Wolf and other mammals. Trophy hunters in North America vie with one another to receive the "Outstanding Hunting Achievement" trophies awarded each year, primarily for having killed one each of 29 big game animals, some of which are on the US Endangered Species Act list (Williams 1991). Trophy hunting organizations have "master measurers" who check the size of horn, antlers and other measurements of animals killed for record books. SCI gives awards to those who kill at least 13 of the world's 22 species of "available" wild sheep (Williams 1991).

Rifles that fire at distant targets with telescopic lenses, elaborate blinds, heat sensors, and other technological gadgetry have weighted the contest so much in favor of the hunter that animals have become mere targets, with virtually no

hope of escape. Hunters using these high-powered rifles revel in recounting their experiences in hunting publications, whose writing fees help pay for their trips. One hunter's 1997 account recorded his delight in seeing the look of total shock of an Alaskan Dall Sheep (*Ovis dalli*) as it died from a shot he fired without it even having been aware of his presence. The hunter had selected the largest male with the most massive horns, which curved into a complete circle. Such hunting can so terrify animals that they run off cliff edges or flee into places from which they cannot escape.

Bernard Grzimek's *Animal Life Encyclopedia* recounts a hunt in the Canadian Rockies of Mountain Goats (*Oreamnos americanus*), in which five animals were pursued by hunters. They fled in terror, becoming entrapped on the ledge of an overhanging cliff, unable to move in any direction (Grzimek 1968). The hunters returned to their camp where they could see the goats as they stood on the ledge. The next day, the goats were still standing on the spot, but during the following days, they gradually became weakened and fell, one after another, usually at night, to their deaths. The last of the animals fell after 10 days (Grzimek 1968).

One US trophy hunter, Donald G. Cox, has hunted in 68 countries, taken 208 different species, including 125 from Africa, and has killed 23 of the world's spiral-horned antelope (Williams 1991). Trophy hunters try to kill as large a number of species as possible and as many trophy-sized animals as they can shoot. Many trophy hunting organizations claim to have made major contributions to conservation, but documentation is often lacking. SCI has published brochures in which it claims that it purchased habitat for endangered species. As it turned out, on investigation these claims were unsubstantiated (Williams 1991). Endangered animals are often the prime targets of trophy hunters. Safari Club International makes regular applications to the Fish and Wildlife Service to import trophies of endangered species. A 1978 application was particularly stunning because it requested permits to import 1,120 animals of a wide range of species, including Orangutans, various species of monkeys and crocodiles, and 39 species of endangered deer, gazelles, wild sheep, antelope, rhinoceroses, and 12 species of endangered wild cats. After a public outcry, the Safari Club withdrew its application, but in 1982, it was successful in its long battle to allow importation of Leopard trophies.

Trophy hunting clubs have made financial contributions to officials in foreign countries to receive permission to hunt endangered species and have convinced wildlife officials in countries such as Pakistan, Zimbabwe and Botswana that trophy hunting fees pay for conservation and should form the basis of wildlife management programs. The profits from trophy hunting pale beside those of ecotourism, however (see Trophy Hunting vs. Ecotourism Revenues section below).

Illegalities

Trophy hunting organizations have lobbied the US Department of the Interior for decades to weaken law enforcement "overzealousness" and have, on occasion, been successful. The Law Enforcement Division of the US Fish and Wildlife Service has tended to be strict in prosecuting trophy hunters for violations. In one case that inflamed Safari Club International members, it subpoenaed pages of the SCI™s *Record Book*, which listed many endangered species, to determine the details of the killing of various protected animals. To shield its members from prosecution, SCI returned information to their members on trophy animals killed at a time when they could not have been imported legally, and deleted this information in the SCI database to avoid further investigations (Williams 1991).

In another case, however, SCI influence won favors from the Department of the Interior. A highly placed official with the Fish and Wildlife Service, Richard Mitchell of the Office of Scientific Authority, allegedly accepted money from SCI in exchange for facilitating permits to get endangered species trophies into the United States (Williams 1991). Correspondence between Mitchell and SCI members included advice on registering as an institution with CITES on behalf of the trophy museum that the organization maintains in Arizona. Mitchell suggested that he would arrange to register several institutions in China and Pakistan in order to trade endangered species "specimens" with them

(Williams 1991). Another official, Assistant Secretary of the Interior G. Ray Arnett, who later co-founded a lobbying organization for trophy hunters, helped a fellow hunter caught importing an endangered species in the early 1980s by ordering agents to return the trophies to the smuggler, Thornton Snider (Williams 1991). Rick Parsons, who founded the Permit Office within the Fish and Wildlife Service, which gave permits to trophy hunters and others wishing to import endangered species, later became the Washington Counsel to Safari Club International, using his government experience to facilitate the permit process for trophy hunters and also lobbying at CITES Conferences on behalf of trophy hunters.

Ted Williams, in a 1991 article in *Audubon* magazine, tells of an appraiser for the Safari Club, R. Bruce Duncan, who arranged for many members of the club to mislabel the trophy animals they killed in foreign countries in order to import them into the United States without prosecution under the US Endangered Species Act (Williams 1991). One Club member imported a Jaguar (*Panthera onca*) pelt from Venezuela, labeled as a "goat hide" under Duncan's advice, and valued at $60; Duncan had appraised it at $11,000 (Williams 1991). Another SCI trophy hunter, Andrew Samuels, was the winner of the 1990 "Weatherby Award" given by a firearms company to the hunter who kills the greatest number of average, as well as record-sized, game animals throughout the entire world and whose character and sportsmanship are "beyond reproach" (Williams 1991). An undercover Fish and Wildlife Service Law Enforcement investigation revealed that Samuels had confided having illegally killed a Bighorn Sheep and numerous endangered foreign animals and smuggled them into the United States by falsifying shipping documents (Williams 1991). These included Jaguars, endangered wild Markhor goats (*Capra falconeri*), rare African antelope, Jentinck Duikers (*Cephalophus jentinki*), Ocelot (*Leopardus pardalis*), and a wild Asian sheep, the Punjab Urial (*Ovis orientalis punjabiensis*) (Williams 1991). Samuels paid $100,000 in fines, spent 30 days in jail, and performed 800 hours of community service; he also forfeited his world hunting rights for three years (Williams 1991).

In another case, John Funderburg, the curator of the North Carolina Museum of Natural Sciences in Raleigh, acquired more than 1,800 animals as "specimens," many of them endangered, that had been killed by trophy-hunting acquaintances (Williams 1991). They were donated to the museum as tax-exempt, but had little scientific value because they lacked information about the location or date where they were killed, and many were merely heads mounted for hanging on walls. Scientific specimens consist of the skins of entire animals, or their skeletons. A number of the donated trophy animals mysteriously disappeared from the collection, apparently returned to the donors (Williams 1991). In exchange for financial "donations" to the museum, the trophy hunters received the title of "associate curator," with certificates that allowed them to misrepresent themselves to foreign wildlife officials in order to obtain permits to kill protected animals (Williams 1991). Funderburg urged the hunters to send him the trophy animals via private taxidermists to avoid the attention of authorities, but a five-year undercover investigation by Fish and Wildlife Service Law Enforcement revealed all the details of this scam (Williams 1991).

The highly respected Smithsonian Institution has not been invulnerable to such unprincipled arrangements. A wealthy real estate developer, Kenneth Behring, pledged $20 million to the Institution's National Museum of Natural History in 1999, the largest donation in the 151-year history of the museum (Golden 1999). Behring, a trophy hunter and past president of Safari Club International, donated the remains of four endangered Central Asian wild sheep, including the Kara-Tau Argali (*Ovis ammon nigrimontana*) of Kazakhstan, listed as Critical by the *2000 IUCN Red List of Threatened Species*, to the museum. This animal cannot be imported legally because it is listed on the US Endangered Species Act, but on behalf of Behring, the Smithsonian petitioned the Department of the Interior to waive the ban in order to have the trophy shipped into their collection (Golden 1999). This action set an unfortunate precedent for this august institution. Behring is also under investigation for illegally killing three bull elephants in Mozambique, in spite of a $20,000 "donation" he made to a local hospital in the province (Golden 1999). The head of Mozambique's wildlife department, Arlito Cuco, said that the hunt was illegal, "Because according to the law in Mozambique, you cannot hunt for sport" (Golden 1999).

Hunting magazines often glorify the pursuit of endangered species. An article in *Sports Afield* encouraged the hunting in Mexico of Jaguar, Ocelot, and "crested Guan," or Horned Guan (*Oreophasis derbianus*), a highly endangered pheasant-like bird (Anon. 1981). It noted parenthetically, "However, United States laws prohibit bringing in skins"

(Anon. 1981).

Effects of Trophy Hunting on Animals

Among the most coveted of the "Grand Slam," or the most prestigious trophy animals, is the Brown Bear. The Kodiak Bear (*Ursus arctos middendorffi*) of Alaska represents a major trophy for hunters who come from all around the world to kill large males. This bear exceeds other subspecies in size, weight and skull size. These bears have been isolated since the end of the last Ice Age, and the abundant food supply of salmon runs, berry bushes and other edible plants in their habitat has produced this giant bear (Chadwick 1990). Trophy hunters pay $20,000 or more to private hunting guides for the privilege of shooting these bears. A recent study has revealed a potentially disastrous effect on the species of this trophy hunting. According to *The Kingdom. Wildlife in North America*, by the respected author and National Geographic Society correspondent Douglas Chadwick, "Continued harvesting of the biggest animals by trophy hunters has caused a decline in the average size of Kodiak Bears over the years" (Chadwick 1990). Thus, this record-size animal is gradually becoming smaller and smaller as a result of trophy hunting.

The pressure of hunters on some populations of Alaskan bears is so intense that it has altered the behavior of males, preventing their normal feeding on salmon runs. On Admiralty Island in southeastern Alaska, part of the Tongass National Forest, tourists watch female Brown Bears fishing with their cubs, but rarely see males because they have become so wary of people after years of being hunted; even females without cubs can be hunted on Admiralty Island (Crittenden 1997). The rich salmon rivers on this island are among the world's most productive, and since clearcutting of timber has been banned, salmon thrive in the clear water. Salmon is an important portion of the diet of male bears, yielding a great deal of protein and helping to fatten them for the winter. By frightening the male bears from the salmon rivers, which they have fished for thousands of years, humans may be affecting the health, survivability and size of these bears. Each year more than 40 Brown Bears are killed on Admiralty, and hunters are lobbying to reopen hunting in areas such as Pack Creek that are now closed to protect the fishing spots (Hanson 1998). This island deserves to be declared a National Park, which would protect these bears from hunting.

Another effect of hunting male bears has recently been documented by Swedish and Norwegian biologists, who found that in areas where resident adult male Brown Bears had been killed to thin the population, bear cubs suffered very high mortality for several years until dominant males reoccupied the territory (O'Neil 1997). Male bears, who have traditionally been considered threats to cubs, may be a danger only to cubs they have not fathered. Thus, the killing of bears by sport and trophy hunters may also result in the deaths of hundreds of bear cubs.

Russian Brown Bears have been hunted heavily in recent years. When a prominent government official, Prime Minister Viktor S. Chernomyrdin, announced early in 1997 that he wanted to trophy hunt a Brown Bear, local guides bulldozed a path to the den of a sleeping female bear (Filipov 1997). Tractors plowed a campsite for a large tent with mobile kitchen and cafeteria, and the Prime Minister flew in by helicopter (Filipov 1997). Chernomyrdin, accompanied by 12 hunters, rode a skimobile to the site, roused the bear and killed her two cubs and the mother. This incident received much adverse publicity in Russia. When the Prime Minister was criticized for his lack of sportsmanship, he replied: "What's wrong with that? Hunting of bears is not banned; it's a normal thing . . . I'd like to watch those who are writing about this meet those bears eye to eye to see their reaction" (Filipov 1997).

In Greece and Turkey, where Brown Bears are avidly hunted in spite of their dwindling numbers, cubs orphaned when their mothers are killed are often sold to zoos or to gypsies who treat them abusively. This trade is illegal in both countries, and the World Society for the Protection of Animals (WSPA) has saved many of these gypsy bears, who are dragged through the streets with nose rings and made to perform tricks. WSPA has placed several hundred of these abused bears in large wooded compounds, unfettered for the first time in their lives. Some had to be euthanized because of severe infections that had caused them extreme pain and serious physical disabilities that they had endured

for many years without veterinary treatment. The majority suffered the effects of malnutrition.

The animals trophy hunters seek--the finest specimens--are the very ones that should be left in the wild to maintain the species. Killing the largest specimens of a species, subspecies or population is likely to diminish it in size and survivability. This would seem elementary, but trophy hunters, state game departments, many in the Fish and Wildlife Service, the World Wildlife Fund and other organizations in favor of trophy hunting do not discuss or acknowledge this fact. Claims are made on behalf of trophy hunters that only old and non-breeding adults are killed, but this contention has been proven wrong in case after case. Brown and Grizzly Bears continue to breed until an advanced age. Other trophy animals have also been shown to be at their prime when shot.

Lions are a prime target of trophy hunters, who select the largest male specimens, especially those with enormous manes. Two filmmakers, Derek and Beverly Joubert, in producing their dramatic series, fiLions of Darknessfl for the National Geographic Society, followed three exceptionally large males for a long period. These magnificent Lions spent most of their lives in a national park in Botswana, but made the fatal mistake of leaving the park and entering a wildlife management area where trophy hunting was allowed. All were shot within a short time at the prime of their lives by trophy hunters.

Trophy hunting took a tragic and highly controversial turn when the government of Tanzania sold trophy hunting rights for African Elephants at more than $4,000 per animal in the early 1990s. The *2000 IUCN Red List of Threatened Species* classifies this species as Endangered. The government claimed that the largest animals, which for trophy hunters were the most desirable, were not active breeding males, but past the breeding age and, therefore, "excess." Tanzania issued 50 permits a year for trophy-hunted elephants (Brody 1994). At least four very tame bull elephants that had been studied for decades in Amboseli National Park in southern Kenya by biologist Cynthia Moss, author of two classic books, *Echo of the Elephants* and *Elephant Memories*, wandered into Tanzania in 1994, where they were shot at point-blank range by trophy hunters (Moss 1995). The hunters had received CITES permits from the Tanzanian government to export the tusks as hunting trophies (Moss 1995). Northern Hunting Enterprises, which organized the Tanzanian elephant hunt, is run by Rick Trappe, a German Tanzanian; the hunters were two Germans and an American (Brody 1994). One of the bulls killed, called "R.B.G.," was 47 years old at the time of his death, based on aging of the jaw--not old in elephant years--and so habituated to vehicles that he could be easily approached to within a few feet (Moss 1995). Cynthia Moss said she was "devastated" by the loss of the animals, who had come to trust researchers, tourists and rangers. She stated: "The message they got from us was, 'It's OK, we're not going to hurt you, you can trust us.' Then one day they walk two kilometers into Tanzania, where they'd been going for most of their lives, and they're blown away . . . I feel as if was lying to them" (Brody 1994). A spokesperson for the African Wildlife Foundation said: "The ethics of shooting these virtually tame animals is appalling. You can't call this a hunt of any kind" (Brody 1994). Had R.B.G. not been shot, he would have lived another 18 years, according to Moss (Brody 1994).

These were among a relatively small number of large, old bull elephants left in East Africa, protected through the ivory slaughters of the 1980s by the presence of field researchers and tourists. The assertion that they were non-breeding males was refuted by Moss, who had documented that they were active breeders and, in fact, among the top breeding bulls in the Amboseli population (Brody 1994). This disputes the view that they were not contributing to the gene pool and were "excess," worthy only of being used as targets. After protests and adverse publicity on television programs that reached the United States and elsewhere, Tanzania announced a ban on trophy hunting of elephants near the Tanzania/Kenya border on December 13, 1994, and initiated an investigation into the granting of permits to shoot the Amboseli bull elephants.

In spite of the supposed ban, two other big bulls of the Amboseli, Sleepy and Beach Ball, both in their 50s, were killed in Tanzania by trophy hunters in 1996. Both had fathered calves that were born after their deaths. The largest bull in Cynthia Moss's study area is the gigantic Dionysus who, at 55 years old, weighs some 6,000 kilograms, with 100-pound tusks. He probably owes his life to Cynthia Moss and other researchers who have deterred poachers, but should he wander into Tanzania, he may be killed. The females in the family, headed by Echo, an old matriarch, prefer

Dionysus above all the males, and he has fathered many calves. In a BBC film about her work in Africa, fiEcho of the Elephants. The Next Generationfl (PBS--WNET 1996), Moss pledged that she would spend the rest of her life watching over these elephants.

Another effect of trophy hunting of elephants and many other animals is an imbalance that is created between the sexes. The largest elephant bulls of both the African and Asian species have been killed off, leaving far too few males for the number of adult females. In some parts of Africa where the ivory massacres were the most intense during the 1970s and 1980s, virtually no adult males remained prior to the 1989 CITES ban on ivory. In Asia, adult male Asian Elephants (*Elephas maximus*), also listed as an Endangered species by IUCN, have become extremely rare because they were killed by ivory poachers. Females do not have tusks, and most have been spared by ivory hunters. In parts of Asia, males without tusks, a recessive trait, have come to dominate some populations, since they are not valuable for their ivory. This is altering the traits of the species.

After the largest bull African Elephants were killed off, trophy and ivory hunters turned to the older females, who have large tusks. They are essential in maintaining and leading family groups, providing experience, protection and guidance (Moss 1995). These older females, or matriarchs, have accumulated survival lore over many decades, acquired from previous matriarchs and their long life experiences. They also know the location of scarce water holes in the dry season, where to find minerals in clay they need for their nutrition, what plants are poisonous and other bits of survival lore that can mean the difference between life and death of herd members. Yet these matriarchs also were killed in the 1980s, leaving young, traumatized teen-aged females, who wandered in disarray, without the knowledge or authority of the older females. Females as young as 10 years old found themselves matriarchs of bands of orphan calves, many just weaned. Without direction, they often blundered, placing the calves at risk.

Scientists studying elephants over the past 30 years have documented hundreds of cases of trauma and apparent mourning when family members were killed. The elephants that suffer the most are the young who see their mothers and relatives butchered in front of them. Researchers in the 1990s have noted that many of these young elephants fail to develop normally and are extremely shy, unable to find food and cope with predators as effectively as adults. Some young males, who were calves when they watched as their families were slaughtered by poachers or in culls in South Africa, were released in national parks where they later became unruly and destructive to property and to other animals. Only when older elephants were released to lead and discipline them did they calm down and assume the peaceful personality that characterizes the species.

Zimbabwe, Botswana and Namibia submitted proposals in 1997 to the CITES Conference that the African Elephant's population in their countries be down listed from CITES Appendix I to Appendix II to allow export of trophy-killed elephants. Zimbabwe requested commercial trade in trophies, and Namibia, non-commercial trade. This proposal was amended to read "for non-commercial purposes" and adopted by the CITES members at the 1997 Conference. This is a step in the wrong direction, as hunters will arrive in these countries from around the world to kill the largest, prime elephants as trophies. Shooting elephants in open country where they have no cover is hardly sport, yet the hunting companies tout their massacre as a feat of bravery. Killing them as they come to drink at the few water holes that remain in the dry season in southern Africa is also unsportsmanlike. Matupula Hunters of Texas calls such hunting "exciting and rewarding." Their brochure states, "With the country dry and surface water limited, the elephant bulls can be tracked going to and from water, or in amongst the woodlands and forest where they feed and lay up" (Scully 1997).

Trophy Hunting vs. Ecotourism Revenues

The irony of the slaughter of elephants and other large mammals for trophies is that the funds accrued from trophy hunting or ivory are miniscule in comparison to the value of these animals as ecotourist drawing cards. In Kenya, a

1989 analysis on the viewing value of elephants found that between $25 and $30 million per year was earned in tourist dollars from people attracted to the elephants alone (Brody 1994). A new project provides a local Maasai tribe with about $23,000 a year from tour operators who camp there primarily to show visitors the big bull elephants that are now so rare in East Africa (Brody 1994). During the long life of an African Elephant, it may produce tourist revenue worth $1 million, distributed to a wide range of recipients, from airlines to travel companies, and to local economies (Currey and Moore 1994). By contrast, a trophy-hunted elephant brings a one-time fee of $4,000 to $20,000. Estimates for African Lions are similar. A fully maned male Lion, according to Lee Durrell (1986) in *State of the Ark*, is worth $500,000 as a tourist attraction, whereas a Lion shot for sport or trophy is worth between $3,500 and $8,500, and its skin about $1,000.

Ecotourism has shown an astronomic rise within the past decade, with magazines, books and films aimed at the ecotourist and soaring revenues accruing to countries that protect their natural heritage. Most tourists prefer to come to a country where the animals are tame and where senseless killing is not carried out. Countries that allow hunting of the largest specimens of their wildlife, whether elephants or Leopards, are likely to suffer loss of tourist revenue because they have fewer larger animals and the hunted species often become either shy, hiding from tourists, or belligerent, charging them. A recent article in *Africa. Environment and Wildlife*, a magazine affiliated with World Wildlife Fund South Africa, gave advice to tourists coming to Okavango. Daryl and Sharna Balfour (1998) recommended that tourists avoid coming during hunting season, which runs from early April to mid-September, because game is "scarce in this areas, skittish and almost impossible to approach." They further noted that the sound of gunfire and the sight of carcass-laden vehicles can be disconcerting (Balfour and Balfour 1998). Wildlife can remain shy throughout the year, especially sensitive, gun-shy animals like elephants, and even beyond the suffering caused to the animals, this trophy hunting potentially deprives the country of far greater revenues that tourists could contribute. Several tourists have been killed recently by charging African Elephants in areas where the animals had been trophy hunted.

Tourists coming to South Africa have increased in number in recent years, producing revenues totaling $6 billion in 1995; a large percentage of this total derives from tourists coming to see scenery and wildlife. By contrast only $2 million in trophy hunting fees for rhinos, and a few million dollars more for other animals, were earned in that year, according to the Natal Parks Board (Hughes and Brooks 1996).

Botswana earns $100 million per year from tourism and only a tiny fraction from trophy hunting, yet the government actively promotes the latter activity and has failed to give national park status to its crowning jewel, the Okavango Delta. Portions of this superb wildlife area have been designated as game reserves which allow hunting, but most remains unprotected (Balfour and Balfour 1998). By contrast, Kenya has designated vast areas as national parks and has encouraged ecotourism for decades, with the result that the government earned $500 million in 1996, up from $452 million in 1995. A new organization, Okavango Peoples' Wildlife Trust, in Botswana, is pressing for a complete ban on trophy hunting in the immense Okavango Delta wetland (Jackman 1997). As a result of livestock fencing in the area, African Buffalo are declining 18 percent a year, and Lion, zebra, Sable Antelope and waterbucks are also becoming scarce (Jackman 1997). This organization has proposed that all hunting, except for subsistence or problem animals, be banned and that the Delta be promoted as an ecotourism center, with low-impact camps for luxury visitors (Jackman 1997). New fencing has blocked about one-fourth of the Okavango to wildlife, who migrate to this oasis from surrounding desert areas as a vital refuge for many months during the year. These fences also have blocked wildlife migrations between Namibia and Angola, a disastrous event for many thousands of animals (Jackman 1997). This region has enormous potential for ecotourism that would far outweigh the revenues from cattle ranching or trophy hunting.

In general, funds from trophy hunting end up in government coffers and in the pockets of a few tour operators; the people of a country receive little of the revenues. By contrast, ecotourism funds are spread throughout the local economies, with hotels, taxis, buses, restaurants, souvenir shops and others benefiting from the greater number of tourists than hunters. In fact, the number of trophy hunters is miniscule in comparison to the number of ecotourists. In most countries, hunters amount to a few hundred or thousand, versus hundreds of thousands--or even millions--of

tourists. In some countries, a portion of trophy fees and the meat from slaughtered animals are shared with local villagers, but if they were given the same share of tourist money, it could be very profitable. This trend of sharing tourist revenues or park fees with local people is making an enormous difference in the lives of people around the world.

Meat Hunting

Three Asian wild cattle are endangered from hunting, and one of these is on the verge of extinction. The Kouprey (*Bos sauveli*), discovered in 1937, is classified as Critical by the *2000 IUCN Red List of Threatened Species*. Native to open lowland forests of Southeast Asia in Cambodia, Laos, Thailand and Vietnam, it is the size of a steer. Adult males weigh up to 1,980 pounds and stand 6 feet tall at the shoulder (Nowak 1999). Originally, the Kouprey's habitat consisted of low, rolling hills interrupted by patches of forest; it grazed in herds of up to 20 animals, covering some 15 kilometers a day in the open areas and entering the forest for shelter from the sun and refuge from predators (Nowak 1999).

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Meat Hunting: Page 1

Today, much of the Kouprey's habitat has become a battleground for bands of guerrillas who have planted land mines throughout the region and hunt and snare wildlife for food. After the Vietnam War and the Khmer Rouge occupation of Cambodia, Kouprey were only seen rarely (Stewart-Cox 1995). A 1986 survey found fragmented, small populations remaining in most of its range (Nowak 1999). A few Kouprey were seen in the 1980s trying to migrate through the steep escarpment separating Cambodia and northeast Thailand, but they apparently died in booby-traps set for people (McNeely and Sochaczewski 1988). The skull and horns of a female Kouprey were offered for sale in a shop in Poipet, Cambodia, in 1994 for $400, according to biologists surveying illegal trade in the country (Martin and Phipps 1996). The Kouprey has little chance of surviving without protection from hunting unless a large sanctuary is set aside for it. No strong conservation measures have been taken to date. No Koupreys are in zoos. It is possible that this species is already extinct.

The Banteng (*Bos javanicus*) is similar in size to the Kouprey, with upturned horns and an extremely stocky build. Brown to bluish-black, Bantengs have white legs and a white rump patch. Their range is larger than that of the Kouprey, extending from India to Myanmar (Burma), Thailand and Indochina, south through the Malay Peninsula to Java and Borneo. These animals are being crowded out of their forest and shrubland habitat by settlements and logging, and they are extremely vulnerable to hunting. They have become wary and shy, and large herds are now rare. Banteng have been domesticated in Indonesia and bred with domestic cattle, producing fertile offspring (Nowak 1999). Wild, genetically pure Bantengs are extinct in Bangladesh, Brunei, and probably India as well, according to the *1996 IUCN Red List of Threatened Animals*. The 2000 version of this list also classifies the species as Endangered.

The Gaur (*Bos gaurus*), largest of the three Asian wild cattle, is the most numerous, yet it is listed as Vulnerable by the *2000 IUCN Red List of Threatened Species*. Ranging from Nepal and India to the Malay Peninsula, these massive animals weigh up to 1,000 kilograms (2,200 pounds) (Nowak 1999). They have become extremely rare to absent in all

but protected national parks, and their populations have been estimated as extremely low, only about 1,000 animals (Nowak 1999). These animals are killed whenever possible for their meat throughout their range.

The Annamite Mountains extend along the border between Laos and Vietnam, rising to more than 6,000 feet in some areas, where stands of wet evergreen broadleaf forest harbor some of the strangest and rarest mammals on earth. Not until the 1990s were these remote forests explored by scientists, who examined skins and horns of rare animals killed by Hmong tribespeople. First to come to light in 1992 was the extraordinary Sao la or Vu Quang Ox (*Pseudoryx nghetinhensis*), a beautiful, gray, goat-like antelope. Its genus, *Pseudoryx*, meaning false oryx, indicates its superficial resemblance to oryx because of its long, straight, backward pointing horns. Weighing up to 200 pounds and 35 inches tall, this relatively large animal somehow had escaped the attention of scientists. (See photo in Nowak 1999.) Soon after discovery of several pairs of its horns, rewards were offered for live specimens. Two young calves were captured in Vietnam and placed in the Hanoi Zoo; within weeks, both were dead (Rabinowitz and Schaller 1994). Others were captured by villagers hoping to receive rewards, and some of the animals died (Nowak 1999).

The Hmong people know the Sao la well and hunt them whenever they can. They believe these antelope number at most a few hundred animals (Rabinowitz 1997). Many have been killed since their discovery, and hunters indicate that it has disappeared from some areas (Nowak 1999). Only a few hundred Sao las are thought to exist in Vietnam and Laos, where heavy hunting presents a major threat to them in spite of official protection by the Vietnamese and Laotian governments (Nowak 1999). Wildlife Conservation Society biologist Alan Rabinowitz (1997) estimates that they are restricted to an 800-square-mile portion of the rugged mountain forests along the border. In 1994, soon after this animal was given its scientific name, it was listed on Appendix I of CITES to prevent international commercial trade. The *2000 IUCN Red List of Threatened Species* lists it as Endangered. Vietnam set aside the Vu Quang Nature Reserve for these very rare animals and prohibited snaring in the reserve (Rabinowitz and Schaller 1994).

Other rare and newly discovered or rediscovered animals of the Annamite Mountains include two species of muntjac, or barking deer, one of which is the largest of all muntjac species; a long-snouted, yellowish wild hog rediscovered from a skull fragment; a striped rabbit, based on fur pelts found in a local village, which may be the same species or related to the endangered Sumatra Short-eared Rabbit (*Nesolagus netscheri*); and a very endangered palm civet (Rabinowitz 1997). The muntjacs and palm civet were discovered as captive animals, but nothing is known of the others, and searches for the wild hog have been unsuccessful (Rabinowitz 1997). Had these intriguing and unusual animals been discovered in a wilderness area in North America, they would be the subjects of field surveys and strict protection, as well as extensive media coverage. In Asia, where diversity is far greater and conservation a luxury few can afford, even such fascinating species may fade into extinction for lack of funding for conservation programs.

Throughout the region, much of the larger wildlife, from deer to large predators, has been hunted out, and guerrilla warfare has left the land marked with bomb craters and land mines. Alan Rabinowitz (1997), who has lived in Southeast Asia and witnessed overhunting in many countries, says, "The killing of wildlife in Laos was unlike anything I had seen elsewhere." Even within the Nakai Nam Theun Reserve, "walls of death" were constructed of thatch, bamboo and small trees, with openings rigged with snares; animals walking along the wall would be caught when trying to pass through an opening, snared by a leg or the neck, to "die a slow death" (Rabinowitz 1997).

Meat Hunting: Page 2

A wildlife slaughter of enormous proportions is taking place in Central and West African countries. Rural people who once killed animals only for personal consumption now hunt professionally, and markets in villages and cities now sell thousands of monkeys, antelope, wild cats, pangolins and even endangered apes (Pearce 1995, McRae 1997). Hunters use wire snares and leghold traps, high-powered rifles and dogs to track down animals. The tropical rainforests of west-central Africa, which once teemed with wildlife and echoed with their calls, are now falling silent.

For miles surrounding villages, wildlife has largely disappeared as local peoples throughout this vast region are killing every animal to sell its meat and body parts. Professional hunters have taken so much wildlife that little is left for local tribes. Logging corporations based in Europe have launched this commercialization of bushmeat by opening up previously impenetrable wilderness areas with logging roads and offering to buy animals that local people kill. Both the forests and the wildlife are being devastated.

Logging companies have taken advantage of these impoverished countries' national debts, buying rights to clearcut the majority of the remaining primary tropical rainforest in West and central-west Africa at bargain prices. The last primary forests in Cameroon, the Congo, the Democratic Republic of Congo and the Central African Republic are being cut and bulldozed, and their wildlife exterminated. Five-hundred-year-old trees with massive trunks 20 feet around, standing more than 100 feet tall, fall daily. The old-growth forests that provide homes for a myriad of wildlife will soon be gone at the present rate of cutting. In some areas, the logging is selective for certain species of trees, but this reduces forest diversity, and hundreds of trees are destroyed in the process of obtaining a few. When great trees fall, they bring down others, and logging roads and entry roads into forest tracts take thousands more trees.

In a shocking and moving report, *Slaughter of the Apes. How the Tropical Timber Industry is Devouring Africa's Great Apes* (Pearce 1995), the World Society for the Protection of Animals documents the tragic and gruesome slaughter of hundreds of Gorillas, Chimpanzees and other wild animals in Central African countries in this trade. The commercialization of wildlife and environmental devastation that have resulted are activities totally antithetical to the legislation and conservation ethics of the European countries--France, Germany, Italy, the Netherlands, Belgium and Denmark--that are sponsoring the logging (Pearce 1995). Several documentary films shown on the National Geographic Explorer program and CNN have shown the markets with thousands of small antelope, Chimpanzees, Gorillas, monkeys and other mammals lying dead on tables, offered for sale. fiAfrica Extremefl and fiNdoki Adventurefl are National Geographic films shown in March 2001 that document the discovery of poachers' camps with dead forest antelope, Leopard skins and other wildlife. One incident of snaring was filmed. A hunter filmed in the remote Ndoki Forest of the former Zaire found a Forest Pig struggling in a wire snare. The hunter began hitting the pig in the head to cause death, while the animal screamed and kicked. Only after hitting the animal about six times did death finally occur. Local hunters interviewed by the photographers said they regularly killed Bongos (*Boocercus euryceros*), rare and extremely beautiful rainforest antelope that are closely related to giraffes. These films traced the 1,500-mile voyage by Wildlife Conservation Society biologist Michael Fay through the last rainforests of the Democratic Republic of Congo and Gabon to publicize the fact that these magnificent wildernesses are being logged and their wildlife killed, and urgent action is needed to stop these activities.

Hundreds of Lowland Gorillas are being killed for the meat trade and sold for $40 per animal. Loggers place orders for Gorilla meat, which encourages the snaring and shooting of virtually every Gorilla that local people are able to procure for this grisly trade. WSPA found that in one district of the Cameroon, 800 Gorillas a year were being killed (Pearce 1995). Swiss photographer Karl Ammann has spent years fighting this trade (McRae 1997), and in the late 1990s, conservationists from around the world began efforts to save these beleaguered apes from slaughter.

In the forests of southeastern Cameroon, Ammann and Michael McRae, a journalist, found an infant Gorilla being kept in a dark mud-hut; the tiny animal was cowering in the corner, grinding its teeth and straining against its tether. The owner explained that the Gorilla™s parents had been shot two weeks earlier by a village hunter, the male having been wounded as he charged to defend the family, but escaping. The mother Gorilla died clutching her baby; she was then gutted and carried out of the bush, cooked and eaten (McRae 1997). Malnourished baby Gorillas are kept to be sold to passing trucks, but usually die within days. Ammann, after years of witnessing these tragedies, concluded, "Chimpanzees have the will to live if they're separated from their family, but Gorillas fall into a depressive state, and just give up on life" (McRae 1997). One baby Gorilla photographed by WSPA had been stuffed into a suitcase, where the Gorilla died of starvation after days of suffering (Pearce 1995). Another baby Gorilla was filmed lying dead in a battered cardboard box. CNN reporter Gary Streiker filmed an orphan baby Gorilla, tied on a string leash, being kicked and taunted. Huge cargo boats chug along the Congo River and other waterways of the Central African rainforest that serve as highways, carrying hundreds of orphan Chimpanzees and Gorillas to markets, stuffed in boxes

and bound with rope. fiDown the Dark River,fl a 1996 film by CNN, captured the squalid and cruel conditions that baby Chimpanzees endured on these boats. When sold as pets, baby Chimpanzees are often placed in outdoor dirt yards, lonely, solitary little gnome-like figures with sad eyes, hugging themselves or clinging to dirty cotton cloths. When they grow older and become strong and difficult to manage, they are usually killed and eaten (McRae 1997).

The total Lowland Gorilla population is not known with any certainty, and "guesstimates" of 100,000 put forth in 1985 are probably greatly exaggerated. Their true numbers are probably half that, and in steep decline (McRae 1997). Several bushmeat hunters were interviewed in fiThe Bush Meat Trade,fl a film shown on the National Geographic Explorer television series in 1995. When asked why they shoot these magnificent and protected animals, the hunters defended themselves by saying: "What's wrong with killing a Gorilla? They're fierce." One of the hunters told McRae that he was sure Gorillas were plentiful: "In Cameroon there are a million Gorillas. Three weeks ago, I saw sixty in one day. I shot three and then stopped . . . Why should I feel bad for a Gorilla? He is just a stupid animal" (McRae 1997). The West African country of Gabon also has markets where huge amounts of bushmeat are offered for sale, including Chimpanzee heads and Gorilla parts (Walters 1996).

Monkeys are killed on sight by the hundreds by hunters for sale in meat markets. Traders on the boat trip filmed in fiDown the Dark Riverfl were transporting some 30 or more dead monkeys, strung together with cord wrapped around their necks. These colorful and delicate rainforest primates are rapidly disappearing throughout their range. Monkeys from the forests surrounding the Congo River are bought by traders from hunters along the boat routes, or by logging truck drivers, and sold for $1 each in cities such as Kinshasa to be smoked for human consumption. Some traders traveling on riverboats specialize in bushmeat and barter with local people for monkeys, apes, turtles and other animals, some kept alive for the journey to preserve freshness of the meat, and others dead, stacked in piles.

WSPA has launched a campaign called EscAPE to encourage African governments to enforce existing hunting laws and police the trade in ape meat and body parts. WSPA personnel have rescued baby Chimpanzees and Gorillas from being sold as pets or abandoned, placing them in zoos or sanctuaries. A conference organized by WSPA invited loggers, conservationists, government representatives and organization representatives to discuss the bushmeat market and possible ways of ending it. The loggers boycotted the meeting, but others attended and, after two days, drafted a long list of resolutions, including enforcing existing laws, instilling conservation ethics, and restricting the logging trade (McRae 1997). In December 1995, Ammann and WSPA presented information on the trade to a committee of the European Parliament, distributing their report (Pearce 1995), and at a subsequent meeting of Afro-Caribbean-Pacific nations and the European Union, 140 delegates passed a resolution urging action (McRae 1997).

The bushmeat trade has become the foremost threat to wildlife in Central and West Africa's forests, an even greater threat than logging (McRae 1997). Urgent action to substitute other sources of income is needed. Ecotourism has been suggested, as well as employing hunters to conduct wildlife counts and become rangers. To date, no coherent program has been set into place, and hunters claim that they will continue to kill large numbers of animals until they find an adequate substitute.

Bonobos (*Pan paniscus*), or Pygmy Chimpanzees, number only about 13,000 in a restricted area of the former Zaire's dwindling rainforests. As the most endangered of the apes, exploitation could cause their extinction. WSPA documented illegal trade in these primates (Pearce 1995).

A study of the bushmeat trade in western Cameroon found serious declines in several other species of primates, caused by the meat trade. The rare Preuss's Guenon (*Cercopithecus preussi*) and the highly endangered Drill (*Mandrillus leucophaeus*), a large monkey listed on the US Endangered Species Act and Appendix I of CITES, are also being hunted for market sale. In one hunt alone, 30 Drills were killed (King 1994). Troops in the area have declined in number. One monkey, the Russet-eared Guenon (*Cercopithecus erythrotis camerunensis*) has been hunted to extinction there, and all primates from the Mount Manenguba region have declined dramatically (King 1994). In Sierra Leone, 300 tons of monkey meat are exported to Liberia each month, decimating wild populations of Red

Colobus (*Procolobus badius*) and Diana Monkeys (*Cercopithecus diana*). All these primates are listed by the *2000 IUCN Red List of Threatened Species* as Endangered. Scientists predict extinction in the region for the Red Colobus in 10 years, and the Black and White Colobus (*Colobus guereza*) in 20 years. Gabonese markets also offer various species of monkeys for sale. In one market, three small monkey heads were lined up on a gutter curb. Two of the faces were expressionless, and the third was open-mouthed, its eyes staring under furrowed brows, "as if frozen in a final, terrified gaze" (Walters 1996).

The Gabonese bushmeat trade, while not linked to commercial logging, has nevertheless grown in size and, in 1993, accounted for almost 11 percent of the country's gross domestic product (Walters 1996). A 1993 study found that, in a single city, more than 5,000 animals of 43 species of mammals, reptiles and birds were sold per year. Guenons; the magnificent and colorful Mandrill (*Mandrillus sphinx*), a Vulnerable species; Black Colobus; Chimpanzees; Gorillas; four species of duiker antelope; pangolins; Brush-tailed Porcupines; mongooses; genets; civets; and African Golden Cats are among the mammals killed for sale in Gabonese markets (Walters 1996). Birds being sold in these markets include crowned eagles, vultures, hornbills, guineafowl and plaintain eaters (a type of turaco). Pythons, Gabon Vipers, Nile Monitors, hinge-back tortoises and even threatened West African Dwarf Crocodiles (*Osteolaemus tetraspis*) were being marketed. Even animals protected under Gabonese law as endangered species are offered openly for sale. In addition to Gorillas and Chimpanzees, the Giant Pangolin (*Manis gigantea*), a race of the Potto (*Perodicticus potto*), and Demidoff's Dwarf Galago (*Galagoides demidoff*), nocturnal primates, all threatened species, could be obtained clandestinely (Walters 1996). In some areas of Gabon, high-ranking government--as well as local--officials supply hunters in villages with rifles and ammunition. Hunters then decimate wildlife and exchange the dead animals with traders for beer or soap. The traders then sell them for large amounts in city markets (Walters 1996). Hunting takes place throughout the forests, which still cover much of the country, and even in protected reserves where hunting is not allowed (Walters 1996).

An environmental organization, ECOFAC, has set up an ecotourism project to attract visitors to one of Gabon's wildlife havens, the Lope Reserve. Paths have been made through the forests, and 24 elevated observation posts have been built by members of the Scottish Primate Research Group, who have spent years habituating mangabeys and Chimpanzees to human contact (Walters 1996). The goal is to provide local communities with an alternate form of income from tourism and, perhaps, to spread the concept throughout the country and elsewhere in tropical forests where viewing wildlife is not as easy as in open savannah habitats.

The wild animal trade of Central and West Africa is obliterating populations of small forest antelope, such as various species of duiker. Twelve species of central and west African duiker are listed in the *2000 IUCN Red List of Threatened Species*. The meat trade and unregulated hunting, accompanied by destruction of forests, are the major threats. These animals are killed by capture in snares, where they may struggle for days. Two small, delicate antelope, both on CITES Appendix II, the Blue Duiker (*Cephalophus monticola*) and Bay Duiker (*Cephalophus dorsalis*), are trapped in wire snares or taken in pit traps in the Cameroon (King 1994). Dismembered duikers were seen in a market in Libreville, the capital of Gabon, in 1995 (Walters 1996).

Illegal snaring for antelope meat in national parks has been a major threat to Mountain Gorillas (*Gorilla (gorilla) beringei*), who number only about 650 animals. Many have lost their hands to snares, but some have now learned to recognize these traps and spring them. In 1995, however, a baby Mountain Gorilla strayed from the group and became snared, crying and struggling in terror for almost 24 hours while family members watched helplessly until Virunga National Park guards cut him free. Others have died in these snares.

Congo's national park, Odzala National Park, an area of 1,000 square miles, until recently had the region's only unexploited populations of African Elephants, African Buffalo and other mammals. Because of a lack of guards, poachers are now invading the park. The European Economic Community has agreed to fund the hiring and training of guards, with help from the Congolese army. This country is nearly bankrupt, like neighboring countries, making wildlife protection extremely difficult. Private hunting safaris enter the Congo rainforest and, for a fee, a foreign hunter can kill rare species of antelope and other wildlife.

Those who eat African monkeys and apes may be risking death. Several people who ate a dead Chimpanzee they found in the forest in Gabon died of the dreaded ebola virus, and the disease threat is not well-known to those who eat the meat of primates. Sooty Mangabeys harbor a virus related to HIV-2, an AIDS-like virus, and McRae (1997) saw a hunter carrying dead mangabeys, dripping blood into scratches on his leg.

In the Amazon, primates are avidly hunted for meat. Russell Mittermeier, head of the IUCN Primate Specialist Group, states that thousands of primates are killed by hunters, causing local extinctions of woolly monkeys (*Lagothrix* spp.) and spider monkeys (*Ateles* spp.) in Peru and Brazil. Forest tribes in Suriname kill very large numbers of primates for food, selling the meat in many local markets. The Wildlife Conservation Society (WCS) has been working with several native tribes in South America, evaluating the effect of their hunting on wildlife. They have found that in many cases, natives were overhunting many animals, causing local extinctions, even when only killing for subsistence. Peccaries of various species have been extremely vulnerable.

Meat Hunting: Page 3

Fruit bats of Asia and Pacific islands are killed in large numbers for food, sold by the tens of thousands to markets in Southeast Asia. Two species of the western Pacific, the Little Mariana Fruit Bat (*Pteropus tokudae*) of Guam and the Mariana Fruit Bat (*Pteropus mariannus mariannus*) of Guam, Rota, Tinian, Saipan and Agiguan have both been exploited so heavily that they are nearly extinct. Both bats are listed on the US Endangered Species Act as Endangered, yet the trade continues. On Sulawesi Island in Indonesia, thousands of bats are caught by young boys using kites to entangle them as they fly overhead. These bats are vital as pollinators of many species of commercially important fruit.

Bushmeat hunters in Indonesia and Malaysia are wiping out the populations of many animals. On the island of Borneo, a study conducted by the Wildlife Conservation Society found that hunting, legal and illegal, was the single greatest threat to wildlife (Bennett 1994). In Sarawak and Sabah, two northern states on Borneo, Elizabeth Bennett and her assistants conducted a three-year study of native hunting. These rural people, who previously had hunted only for subsistence, now hunt to sell the meat to town markets (Bennett 1994). Areas that had been inaccessible were opened up by logging roads, and hunters now swarm in the forests, killing any animal they see (Bennett 1994). Except in the most remote areas, all local people now possess shotguns. Squirrels, which have a great diversity of species on Borneo, nearly disappeared in some areas, along with leaf monkeys (Bennett 1994). Bearded Pigs, macaques, deer and porcupines are hunted, speared and trapped by some tribes (Bennett 1994). The only taboo involves the killing of Orangutans, who are protected by legend. Hunting pressures were so great that Bennett predicted extinctions for many animals, and the effects on the forest ecology were equally dire, as seed dispersers are killed off (Bennett 1994). WCS is working with local peoples to educate them about the effects of their hunting, with the cooperation of the Forest Department of Sarawak and the Wildlife Department of Sabah (Bennett 1994).

On the neighboring island of Sulawesi, formerly known as Celebes, WCS conducted a similar study in the Tangkoko-DuaSudara Nature Reserve. The study found that in the past 15 years, populations of the endemic Bear Cuscuses (*Ailurops ursinus*), bear-like marsupials who hang by their prehensile tails from branches, had declined by 95 percent from hunting (Kinnaird and O'Brien 1996). Crested Black Macaques or Celebes Apes (*Macaca nigra*), tailless, all-black monkeys found only on Sulawesi and listed as Endangered by the *2000 IUCN Red List of Threatened Species*, have declined by 90 percent, due in large part to meat hunting (Kinnaird and O'Brien 1996). An extraordinary turkey-like bird that incubates its eggs in large, leaf mounds, the endemic Maleo (*Macrocephalon maleo*), a Vulnerable species (BI 2000), has declined 75 percent from hunting (Kinnaird and O'Brien 1996). Other endemic species affected by this hunting are the Mountain Anoa (*Bubalus quarlesi*), a CITES Appendix I threatened dwarf buffalo found only on Sulawesi that is on the verge of local extinction, and the threatened, gargoyle-headed

Babirusa (*Babyrousa babyrousa*), a tusked wild pig, whose total wild population is about 5,000 (Kinnaird and O'Brien 1996). Highly organized networks hunt and trade the meat from these threatened species. Some dealers acquire animals on order for traders in North Sulawesi by driving up to 375 miles to buy Babirusa and other meat from forest hunters (Kinnaird and O'Brien 1996).

When native peoples cease hunting for subsistence only and begin hunting for markets, wildlife can be decimated quickly. Even subsistence hunting has been shown to be detrimental in some areas, but when wild animal meat becomes an economic commodity, overhunting usually results. Market hunting in the United States caused the extinction of the Passenger Pigeon (*Ectopistes migratorius*) and Labrador Duck (*Camptorhynchus labradorium*). The Eskimo Curlew (*Numenis borealis*), heavily hunted for meat in the 19th century, is probably extinct as well. The American Bison, Elk, White-tailed Deer and many waterfowl species also nearly disappeared. Following the 19th century slaughters that decimated these animals, laws banning the sale of wild meat from mammals and birds were enacted and remain in force today. In other parts of the world, only extinctions may bring about strong legislation banning market hunting of wildlife.

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Endangered Species Handbook

Trade:

Trade

Introduction

Trade in live animals, plants and the product made from them threatens many species with extinction. Approximately 15 percent of highly threatened mammals and birds have declined as a result of trade (Hilton-Taylor 2000). Internationally, billions of dollars are earned legally and illegally, and each year, more species become exploited. In a classic pattern, wildlife and plants are captured or extracted from their natural environments until they become rare. This rarity adds to their value, and in many cases, such as exotic cage birds, live reptiles and amphibians, and rare plants, for example, the rarer they become, the more they are sought after, increasing their value. Much of this trade is for luxury products or to supply collectors who have a desire to own rare birds, frogs, lizards, turtles or snakes, with no regard as to the effect on wild populations. For others, such as snakes and lizards killed for their skins to be made into exotic leather products, or whales slaughtered for their meat, one species is exploited until it becomes commercially extinct, and then non-endangered species are exploited until these, too, become endangered. Some animal products, such as ivory, are as valuable as gold, threatening elephants, among the most intelligent of all animals. Fisheries for expensive gourmet items, such as caviar, have endangered all Eurasian sturgeon. A majority of fish and shellfish species have been overfished to depleted status.

The fur trade has endangered many species and continues to use the skins of rare cats and canids. A major market for plants and animals to supply the Traditional Medicine (TM) trade has devastated Tigers, rhinoceros and hundreds of species, in spite of laws protecting these species. For the majority of species exploited for this trade, substitutes exist or they are not effective remedies. National and international laws and treaties, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)*, have had major effects on trade in endangered and threatened species, but the illegal trade continues to flourish, worth an estimated $3 billion a year in protected live animals and animal products. Ecological systems worldwide are being disrupted by the removal of predators and other keystone species, causing a loss of biodiversity.

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*CITES is discussed in detail in the Legislation section and reproduced in the Appendix.

The methods used to capture and kill animals for the wildlife trade are often cruel in the extreme. Steel jaw leghold traps and wire neck snares, which cause great pain and injury, produce pelts for "fun furs." Whales die from exploding harpoons thrust into their heads and bodies. Frightened live animals are crowded into cramped, dirty cages and transported to pet shops and laboratories, suffering high mortality along the way. Man's inhumanity to animals reaches an extreme in the wild animal trade.

Whaling

While whales are revealing their intelligence and amazing communication abilities to scientists in one part of the world, they are being ruthlessly slaughtered in another. Once whales swam in enormous numbers in all oceans, communicating in complex sounds that resonate through the water. The beautiful and eerie songs of the Humpback Whale (*Megaptera novaeangliae*) resound for a thousand miles.* Each complex song lasts as long as half an hour, and different populations of these whales improvise their own dialects, evidence of an extremely evolved communication system. We are unable to decipher this language, and our knowledge of whales is extremely primitive. Hydrophones lowered into the icy waters near Bowhead Whales have picked up strange calls ranging from

groans to trumpet-like blasts to loud squeaks.* Through limited contacts, whales have shown intelligence and sensitivity. They soon become tame and friendly when approached by whale watchers. In recent years, Pacific Humpback Whales have approached boats of whale watchers in the manner of the friendly Gray Whales (*Eschrictius robustus*), which swim up to tourists in Baja California, Mexico. The Humpbacks swim close to these boats and turn on their sides, flapping their huge white flippers on the water surface.

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*These sounds can be heard in fiGentle Giants of the Pacific: Humpback Whalesfl (Sierra Club Films) and fiThe Bowhead Whalefl (Wildlife in Production Films and Discovery Productions, 1998), which give an intimate glimpse into the lives of these whales and their feeding, habitat and the animals that share their world.

The devotion of whales to one another has been observed for centuries by whalers whose boats were attacked by distraught and angry whales after a member of the pod was harpooned. Carl Sagan, in *Cosmos* (1980), considered whaling to be monstrous when, instead, we should be seeking to communicate with these "intelligent masters of the deep." Whaling destroyed millions of these marine giants, pushing them close to extinction. A half century of protection has not resulted in their recovery. Many are still killed illegally. Whaling nations, many of them among the wealthiest in the world, continue to kill smaller whales openly, often in defiance of international agreements.

Early Whaling and its Effects

The decimation of the great whales has been going on for centuries, one species after another hunted to commercial extinction or to levels so low that it is no longer profitable to hunt them. Atlantic Gray Whales were hunted to actual extinction as described earlier in this book, and populations of these whales that once inhabited the waters off Korea and the western Pacific were hunted until 1966, when they disappeared (Reeves *et al*. 1992). In the early 1990s a Gray Whale was seen off the coast of Japan for the first time in decades, giving hope that the species might repopulate this area.

In the 8th century, the Basques of northern Spain hunted the Northern Right Whale (*Eubalaena glacialis*) for meat and whalebone in the Bay of Biscay, where they came to winter and have their calves. These whales once swam along the Atlantic coasts of Europe and North America in annual migrations, spending the summers in northern waters and winters in the warm waters off Florida and Spain. They were so named by English whalers because they were "right" for their purposes: they were easy to kill; they yielded large quantities of oil and whalebone, which was used for women's corsets; and they floated when dead (Allen 1942). The slow-moving Right Whales feed on plankton and krill, which they strain through baleen plates in their huge mouths.

By 1800, almost no eastern Atlantic Right Whales survived, and whalers sailed to American waters, where New England colonists slaughtered the western population. Where once thousands of these whales swam along coasts of eastern North America each fall, few remained after centuries of whaling (Allen 1942). Killing of this beleaguered species continued from whaling stations off Ireland and the Hebrides in spite of catches of only 10 to 18 whales a year. These whalers could find no more Right Whales by about 1910. Fortunately, a few remained elsewhere, but the species is the most endangered of all whales. Still extinct in the eastern Atlantic, they number only about 350 animals in the western Atlantic. In the eastern North Pacific, Right Whales once ranged from central Baja California, Mexico, to the Gulf of Alaska and into the Bering Sea; along the Asian coast, they were seen from the Bonin Islands north to the Kamchatka Peninsula of Russia (Leatherwood and Reeves 1983). Today, the North Pacific population is estimated by some experts at fewer than 300, having failed to recover from early whaling (Harrison and Bryden 1988). This species is on the edge of extinction.

The remnant eastern Atlantic population no longer swims close to shorelines, which are now cluttered with vacation homes, marinas and cities. Their ancestral feeding grounds are polluted, and constant boat traffic presents the threat of collisions. Swimming far offshore, they take months to reach their wintering grounds. A dead Right Whale calf was discovered in salt marshes in Georgia about a decade ago, probably the victim of a boat collision. This launched a research program to locate wintering whales by air and to tag and identify them as individuals. Dredging boats along the Georgia coast are notified when Right Whales are spotted nearby, and they must stop until the whales swim away. Further north, another team monitors the whales off New England in the summer with spotter aircraft, notifying ship pilots of their presence (McFarling 1994). Most collisions have taken place off Boston, where a stream of liners and giant cargo ships arrive from Europe. Off Florida there have been fewer incidents, as the Coast Guard keeps a very careful watch by air and immediately radios any ship in the area of the whales™ location.

Genetic analysis of the DNA of Northern Right Whales has indicated that they may be inbred and becoming sterile, having been so reduced by whaling that only a very small number of whales remain alive. Scientists have obtained small tissue samples from these whales by firing arrows attached to lines that can be retrieved after firing. Preliminary results indicate that all North Atlantic Right Whales may have descended from only three families on the female side and, perhaps, from as few as three individual females (Allen 1995). Since the majority of individual whales have been identified, it is known that at least 13 of 65 sexually mature females have had no calves since 1989 (Allen 1995). In a species that reproduces so slowly and is suffering such casualties from ship collisions, this may spell extinction. The rate of increase for these whales is only about 2 percent. By contrast, Southern Right Whales (*Eubalaena australis*) in the South Atlantic and Antarctic waters, which numbered 100,000 until they were decimated by whaling (Leatherwood and Reeves 1983), are increasing at a rate of 7 to 8 percent a year, far faster than the North Atlantic population. However, with a population of only about 3,000, they are still highly endangered (Allen 1995).

The Bowhead Whales (*Balaena mysticetus*) of the North Atlantic and Arctic Oceans were killed in great numbers from early times by whalers from England and the Netherlands, nearly causing the whales™ extinction (Lean and Hinrichsen 1992). Beginning in the 17th century, on the other side of the Atlantic, whalers from Nantucket Island, Massachusetts, pursued Sperm Whales (*Physeter catodon*) for their valuable oil, which was used in lamps and as lubrication. With a fleet totaling 150 ships, they eliminated the majority of these whales. Then in the 18th century, whalers discovered the enormous numbers of Sperm Whales in the Pacific. By 1846, New England whalers had 736 ships at sea, and only the discovery of petroleum in Pennsylvania saved the Sperm Whales. Right Whales, Gray Whales and Bowhead Whales of the Pacific were all mercilessly hunted until they, too, neared extinction (Allen 1942).

When an explosive harpoon was developed in Norway in 1865 that could be fired into a whale's body from a cannon mounted in the bow of a ship, a new wave of slaughter began (Allen 1942). Its deadly power was soon turned on the rorquals (Humpback; Blue (*Balaenoptera musculus*); Fin (*Balaenoptera physalus*); and Sei Whales (*Balaenoptera borealis*) far away from shore. These whales had been difficult for whalers to take prior to the development of the explosive harpoon because they were swift and strong swimmers of the open ocean (Allen 1942). The new explosive harpoons, although deadly, did not kill instantly, and these whales suffered slow deaths. The huge numbers taken by these harpoons over the next decades caused their populations to decline to commercial extinction.

Factory Ship Whaling

Whalers then turned to the Antarctic where vast numbers of Blue, Humpback, Sei and Fin Whales migrated each summer to feed on the abundant krill. In 1903, the first "floating factory" whaling ship sailed from Spitzbergen, Norway. These ships, when moored near a land base, could process whales brought alongside by small killer boats.

The initial victims of these new ships were the Antarctic Humpback Whales which congregated each summer near the Antarctic Peninsula. The factory ships were joined by some older vessels, and exploitation was unrelenting. About 70,000 Humpback Whales were killed between 1909 and 1913, and by World War I, these whales were almost extinct in the Southern Ocean (Garrett 1981). The toll of Antarctic whales taken in the early 20th century was staggering: more than 122,000 were killed between 1909 and 1927 (Reeves 1979). Humpback Whales finally received protection in 1966 from the International Whaling Commission (IWC), but pirate whalers as well as certain Caribbean nations continue to hunt them.

Factory ships were developed in 1925 with rear slipways through which whales could be winched onto the ships. Whales could be killed either in the open ocean or near ice floes and pulled onto the deck for flensing and rendering (Garrett 1981). With this development, the fate of the vast populations of Blue and Fin Whales of the Antarctic was sealed. First the Blue Whales were slaughtered. They stayed close to the pack ice, convenient for both factory ships and moored vessels. More than 15,000 a year were taken in the 1920s, with a high of almost 30,000 in 1930 (Allen 1942). Soon these mammoth whales, the largest animals on Earth, declined. By 1934, the average length of Blue Whales killed had dropped to 79 feet; 41 percent of the females caught were immature (Allen 1942). These great whales do not reach sexual maturity until females attain a length of 78 feet. The 1937 International Agreement for the Regulation of Whaling reduced the limit to 70 feet for Blue Whales, thus failing to conserve breeding females (Allen 1942). Between 1910 and 1966, a staggering 330,000 Blue Whales were killed in the Antarctic (Lean and Hinrichsen 1992).

After World War II, the IWC was established under the International Convention for the Regulation of Whaling to "provide for the conservation, development, and optimum utilization of the whale resources" (Ehrlich 1981). Member nations now include both whaling and non-whaling countries. The Scientific Committee of the IWC recommends restricting the number of whales killed when it determines that the species will decline as a result. In the early years of the IWC, these recommendations were rarely followed by whaling nations, and so little knowledge of great whale population, biology and status had been uncovered that quotas were far too high to sustain these slow-reproducing species. The destruction of the great whales is a true biological tragedy. Even after almost 40 years of protection, their populations have increased only slightly. Their life histories are certainly part of the explanation. Blue Whale females, for example, are thought to become sexually mature only when they reach 10 years of age. Gestation lasts 12 months, and the single 23 to 27-foot long calf stays with its mother for about two or three years. Sperm Whales do not mature until they are past 20 years of age, and mature bulls, who are the major breeders, are at least 50 years old. Killing of these whales, which did not end until 1983, wiped out the vast majority of big bull Sperm Whales.

Until recently, it was not known how long whales live. New findings are astounding. A Bowhead Whale recently killed by Eskimos was found to have two stone harpoon blades embedded in its blubber; as reported by *National Geographic* ("Geographica," March 1996). This discovery fixed the whale's age at more than 100 years because the use of stone harpoons ended a century ago when metal tools were brought to Alaska. The whale was only a few years old when it was wounded by the handmade pointed tool, and Stephen Loring, an Arctic specialist at the Smithsonian Institution, estimated that when killed, it was between 100 and 130 years old. Further research by the Scripps Institution of Oceanography on three Bowhead Whales killed by Inupiat Eskimos in northern Alaska estimated their ages at death at between 135 and 172 years old. The age of a fourth Bowhead was estimated at 211 years old, which would make the Bowhead Whale the longest-living of all animals, surpassing the oldest known land tortoises. The ages were determined by studying changes in amino acids in the lenses of the whales' eyes. Harpoon points made of ivory and stone, not used since the 19th century, have been found in other Bowhead Whales killed in recent years. Moreover, several generations of hunters have spoken of seeing the same Bowhead Whales, which they recognized as individuals based on their markings.

Whales knew few enemies in the sea before man, and they evolved no defenses that could have protected them from harpoons tearing through their flesh, nor could they increase their rate of reproduction to compensate for the extremely high kill. Another factor hampering their recovery has been illegal whaling. Blue Whales and other endangered species were illegally harpooned long after they received official protection, and this is still taking place.

During its first 30 years, the IWC permitted the deaths of 1.5 million great whales (Bright 1991). It pushed the very species that it had taken responsibility to conserve closer to extinction. Blue Whales, the largest whales, measuring up to 100 feet, were totally eliminated, and smaller and smaller whales were caught. The average length of the Blue Whales caught had declined to 73 feet by 1965 (Scheffer 1974). At this point, when the species had been reduced to only 6 percent of its original numbers, the IWC finally accorded protection (Scheffer 1974). Blue Whales number only about 12,000 worldwide. All populations of this whale in the Southern, Atlantic and Pacific Oceans are listed as Endangered by the *2000 IUCN Red List of Threatened Species*.

Decimation of 81-foot Fin Whales in the Antarctic followed until their populations collapsed early in the 1960s. Fin Whales in the North Atlantic became overexploited in the 1970s. Whalers then turned to the Sei Whales, fastest of the whales, a sleek species reaching a length of up to 58 feet (Heintzelman 1981). When these whales became depleted, the Minke Whale (*Balaenoptera acutorostrata*), the smallest of the great whales at less than 33 feet long, became the major prey of whalers.

The Cruelty of Whaling

Added to the decimation of entire species, whaling involves great cruelty. An eyewitness on an Australian whaler in 1977 described the long death of a great whale:

> *The harpoon seemed to pass right through it, which can happen and the second explosion took longer. The whole event this time seemed in slow motion. The whale dived, and a great green cloud burst up to the surface. Blood turns green underwater at 50 feet...or was this some of its intestines? It came up on the starboard side, its huge head, a third of its total body size, shaking itself, and then it gave out a most terrible cry, half in protest, half in pain, and then it dived again. They loaded the next harpoon, the killer, but could not get a shot at it as it twisted and turned, hurting itself all the more. Finally, the lookout in the crow's nest shouted down that it was coming up dying. Its mouth was opening.*

Australian Government Printing Office. *Whales and Whaling*. 1979.

No method exists to kill whales instantly. The cold harpoons used by some native peoples and by other whalers to kill thousands of Minke Whales are cruel, sometimes taking an hour to kill. Native whaling methods are not regulated. The trauma and rage experienced by stricken whales was documented by Greenpeace activists who sailed to the North Pacific in 1975 in order to place themselves between Russian whalers and their prey, the Sperm Whale. One of the first observations was a small whale, well under the 30-foot limit, floating dead on the water. The Greenpeace crew positioned their rubber raft between the killer boat and the whales, believing that the harpooner would not shoot the 250-pound harpoon with the possibility of killing their crew, but they were mistaken (Ellis 1991). The harpooner fired over their heads, scoring a direct hit on a large Sperm whale; the whale died in a sea of its own blood and guts. Then another whale in the pod charged at the Greenpeacers (Ellis 1991). As soon as the huge Sperm Whale perceived they were not the harpooners, it headed instead for the Soviet whaler, with its powerful jaw clapping; "this whale charged the harpoon boat and seemed to leap out of the water in an attempt to get to the gunner" (Ellis 1991). When the whale was close to the whaling boat, the gunner pointed his cannon almost straight down and shot the whale, killing it (Ellis 1991).

The whale filmed by Greenpeace had made a valiant attempt to destroy the gunner who had killed its fellow whale, perhaps its mate, and had also realized that the Greenpeacers were not at fault. Killing such an intelligent and courageous animal for commercial profit is absolutely unjustifiable. Sperm Whales have, in fact, the largest brains of any animal, weighing 20 pounds (Ellis 1991). Yet we know little of their intelligence, habits and biology. Some scientists have theorized that Sperm Whales stun their prey with sonic blasts; they descend to depths up to 2 miles and are known to feed on Giant Squid, perhaps after stunning and holding the squids™ slippery bodies in their sharp teeth (Ellis 1991). There is oil in the whales™ heads, which may play a role in such acoustical feats.

In 1981, a major humane victory was won. The cold harpoon was banned for all commercial whaling effective at the end of 1982. The decision was a precedent-setting event. Humaneness became an issue to be considered, and the IWC undertook the responsibility to insure that methods are not unnecessarily cruel. This is a relative term, however, since all existing methods are intrinsically painful and inhumane. At the 1995 IWC meeting, a Workshop on Whale Killing Methods heard a research paper on the killing of Minke Whales. These whales are first mutilated by an explosive grenade then, several minutes later, shot with rifles or prodded with an electric lance. Although some have considered these methods to result in a quick death for the whales, researchers have maintained through examination of physiological evidence that breathing and heartbeat continue even when the body is immobilized. The limp and dying Minke Whale may be sensitive and capable of experiencing both fear and physical distress for significant amounts of time. In fact, the IWC tacitly acknowledged at its 1995 meeting that the electric lance was inhumane by passing a Resolution calling for a suspension of its use. At the 1996 IWC meeting, a United Kingdom/New Zealand proposal to ban the use of the electric lance failed.

During a recent investigation of the killing of Minke Whales by Norway for *National Geographic*, a whale already struck by a lance carrying a thermal grenade revived as it was being reeled on board (Chadwick 2001). It rammed the ship, causing the mast to break and sending two crew members into the sea; it then escaped (Chadwick 2001). Its fate is unknown, but its survival is unlikely.

Another cruel aspect of whaling is the killing of female whales, leaving their calves to starve. Some whalers in the past killed calves first, knowing their mothers would not desert them. In 1935, the killing of mothers and calves was finally prohibited by the IWC, but some whalers did not abide by the prohibition. Moreover, the rule may be impossible to enforce. The harpooner who fires into a pod of whales can hardly be sure that the whale he hits is not a female with calf.

Pirate Whaling

A young female Blue Whale was harpooned off the Peruvian coast in 1978, more than a decade after their killing was made illegal. As described by Craig Van Note in his expose, *Outlaw Whalers*:

A 150-lb. harpoon had been fired into the side of the whale . . . after penetrating three feet, a massive grenade at the tip of the harpoon exploded, tearing the whale's internal organs to a bloody pulp with jagged, fist-sized metal fragments. In her agony, the . . . whale tore at the heavy barbs that had expanded from the sides of the harpoon. Wrenching her 75-ton body, she pulled free from the harpoon and heavy rope that ran back to the catcher boat. With a gaping wound in her side, the whale dove deep to successfully escape her pursuers. But the terrible wound caused massive hemorrhaging and each succeeding day the whale grew weaker. Finally she could not hold herself up to the surface to breathe. So she swam ashore through the surf, sliding to a halt on the coarse sand at Conchan. There Peruvian conservationists gathered to witness the final hours of life of the blue whale. She lay on her side, with the harpoon-wound facing shore, gasping for breath" (Van Note 1979). The late Felipe Benavides, a Peruvian conservationist who fought to drive the foreign whalers from Peru's shores for 30 years said, 'This young whale was one of the most beautiful creatures I have ever seen. Watching her die was one of the saddest experiences of my life' (Van Note 1979).

In *The Blue Whale*, which won the National Book Award, George Small (1971) described case after case of illegal whaling. The Greek shipping magnate Aristotle Onassis, one of the world's wealthiest individuals, wantonly killed thousands of critically endangered whales. In the 1950s, a whaling fleet owned by Onassis illegally slaughtered numerous female Blue Whales as well as their nursing young. Its factory ship, the *Olympic Challenger*, registered in Panama, became a notorious pirate whaler; seven German citizens who served on this ship signed affidavits at the Norwegian Consulate in Hamburg in 1956, testifying that they had witnessed innumerable illegal whaling practices and had photographic evidence of whale carcasses and ship's logs (Small 1971). Among the infractions of the *Olympic Challenger* in 1954 was the slaughter of 285 Blue Whales, 169 Fin Whales, 105 Humpbacks, 4,648 Sperm Whales, and 21 Sei Whales. The ship declared a catch of only 2,348 Sperm Whales. Of the Blue Whales killed, many were young: 35 were 59 feet or less in length and two were less than 49 feet (Small 1971). IWC rules at that time prohibited all factory ship whaling of baleen whales between the Antarctic and the Equator (Small 1971). Onassis' ships shot baby Sperm Whales before they even had teeth; some were only 5 meters long and must have been newborn calves (Small 1971). On occasion, four young whales at a time were hauled on board by winch; often a whale was so small that it was only necessary to remove the harpoon and entrails before the carcass was dropped whole into the cookers (Small 1971). The entrails of baby whales jettisoned by the *Olympic Challenger* floated for some time, providing evidence of its illegal whaling (Small 1971). After many protests were lodged, Onassis made a payment of $3 million to a special fund, which was taken as an admission of guilt (Small 1971).

In 1994, records from Soviet whalers were uncovered, documenting the illegal killing of hundreds of Blue Whales for decades, beginning in the 1950s and continuing long after they had been officially protected. These whales, under the direction of the KGB, developed sophisticated methods of preventing detection. The decks were surrounded in steam, hiding the carcasses of protected species, including highly endangered Right Whales. Several hundred of these whales were killed in the Okhotsk Sea in the 1960s, and more in the South Atlantic (AWI 1994). The Soviets™ radio communications were coded, and messages such as "Sink the prohibited whales" were sent when aircraft appeared overhead. Professor Alexey V. Yablokov, a member of the Animal Welfare Institute's Scientific Committee, examined these records, which revealed this shocking flouting of whaling bans. Yablokov studied cetacean morphology during the 1950s and 1960s and received many specimens from Humpback and Right Whales that had been killed illegally (AWI 1994).

EFFECTS OF WHALING ON THE GREAT WHALES (chart)
The figures below represent estimates based on the sources cited.

Species	Northern Hemisphere		Southern Hemisphere		Totals		
	Original	Present	Original	Present	Original	Present	% Change
Blue ***Balaenoptera musculus***	20,100	4,300	200,000	10,000	220,100	14,300	- 94%
Bowhead ***Balaena mysticetus***	43,000	7,850	Not Present		43,000	7,850	-82%
Fin ***Balaenoptera physalus***	95,000	63,000	600,000	15,000	695,000	78,000	-89%
Gray ***Eschrictius robustus***	45,000*	22,000	Not Present		45,000	22,000	-51%
Humpback ***Megaptera novaeangliae***	50,000	8,000	100,000	20,000	150,000	28,000	-81%
Right ***Eubalaena glacialis*** ***Eubalaena autralis***	100,000	600	200,000	3,000	300,000	3,600	-99%
Sei ***Balaenoptera borealis***	400,000	21,100	190,000	8,300	590,000	29,400	-95%
Sperm ***Physeter catodon***	1,500,000	103,000	1,500,000	128,000	3,000,000	231,000	-92%
Totals	2,253,100	229,850	2,790,000	184,300	5,043,100	414,150	-61%

Hemisphere Totals			
	Original	**Present**	**Change**
Northern	2,253,100	229,850	-90%
Southern	2,790,000	184,300	-93%
Totals	5,043,100	414,150	-92%

***Includes estimations of extinct populations of Atlantic and western Pacific** Sources: *Walker's Mammals of the World*, by Ronald M. Nowak, Sixth Edition, Vol. II, Johns Hopkins University Press, 1999, which assesses various sources & research by the Animal Welfare Institute.

The Long Battle for the Whales

The first major step toward ending whaling came in 1971 when the U.S. Secretary of the Interior banned commercial whaling by the United States. Also in 1971, Congress passed a Resolution calling on the Secretary of State to negotiate a 10-year moratorium on commercial whaling with other nations. The 1972 Marine Mammal Protection Act (MMPA) banned all harming and killing of marine mammals without a permit, further protecting whales. The same year, Canada stopped commercial whaling after failing to fill quotas allocated by the IWC (Ellis 1991). Years later, however, Canada became one of the countries voting against whaling moratoriums at IWC meetings. Listing of the great whales on the U.S. Endangered Species Act of 1973 banned import and export of eight species, thereby cutting off commercial imports of whale meat. At its 1972 meeting, the IWC rejected the U.S.

proposal for a moratorium, instead voting a quota of 45,000 whales.

The Long Battle for the Whales: Page 1

For more than a decade, conservation and humane organizations fought to reduce quotas set by the IWC of whales that could be killed. Gradually over the years, representatives from non-whaling countries joined the IWC and voted for lower quotas. Public opinion in most countries is solidly on the side of the whales. The fight to stop commercial whaling through decisions of the IWC was finally won when a moratorium was passed in 1982. At present, virtually all the large whales and several smaller whales have been listed on the U.S. Endangered Species Act and banned from international trade through their listing on Appendix I of CITES. Japan refused to accept the CITES listings and took reservations on most species of great whales, meaning that it gave notice it will not enforce these listings. Any country may choose to do this without losing its membership--a major CITES loophole. Today, Japan retains reservations on Baird's Beaked Whale (*Berardius bairdii*), Sei, Bryde's (*Balaenoptera edeni*), Fin, Minke and Sperm Whales, although officially it stopped importing whale meat in 1992 (Chan *et al*. 1995a). When the ban on commercial whaling voted by the IWC took effect in 1986, many believed that the long fight had been won. Unfortunately, whaling continued in various forms--some allowed by the IWC, and some in defiance of it. On May 19, 1992, the U.S. House of Representatives set an excellent example when it voted unanimously to pass a Resolution supporting an indefinite moratorium on whaling, stating, in part, "Whereas there is significant widespread support in the international community for the view that, for scientific, ecological, aesthetic, and educational reasons, whales should no longer be commercially hunted . . ." This Resolution did not, unfortunately, change the minds of the few nations who continue to kill whales.

Aboriginal whaling by the Inuit tribe and other native peoples has long been permitted under quota by the IWC, even for endangered species such as Bowhead and Humpback Whales. The IWC, at its 1993 meeting, called upon its Scientific Committee to investigate management regimes to govern subsistence whaling in order to minimize depletions of whale populations. Inuits in Alaska have continued whaling as a tradition--more than a need--since they have received substantial settlements from the U.S. government, and some lease their lands to oil and gas companies for high royalties. A Bowhead Whale killed in a hunt in 1996 had been stabbed by 14 harpoons and shot with countless bullets before it died (Vlessides 1998). After two days, it rose to the surface and was towed to shore, one of the few of these endangered whales to have been taken in the eastern Canadian Arctic since hunting the species without a license became illegal (Vlessides 1998). Bowhead Whale populations in the eastern Arctic had fallen from more than 10,000 to about 700 in 1996, but this hunt was to be a rebirth of an old Nunavut tradition (Vlessides 1998). The Inuit used sonar devices to search for the whale after it had been struck and shot, and they carried satellite phones. When the whale was towed to a rocky beach, 100 villagers sliced a ceremonial piece of blubber from the whale, then the hunters left and the meat was never cut. The dead Bowhead rotted on the beach, and the following spring, the community members paid to get rid of the carcass, some of which was set adrift on ice floes and the rest burned (Vlessides 1998). This whale, which might have been more than 100 years old, died a slow and painful death for no good reason.

Another Bowhead Whale was killed off the Northwest Territories in 1998, with an exploding harpoon gun. It was

smaller than normal adults, only 43 feet instead of 60 feet long, and was fed on by natives of various Inuit settlements (Nickerson 1998). The International Whaling Commission condemned the hunt in a formal Resolution and implored Canada to ban it, as did many activists and conservation organizations (Nickerson 1998). In the waters where this whale was killed near Baffin Island, these whales have not rebounded in numbers from past whaling. Canada left the IWC in 1982, insisting that it is no longer a whaling nation, and defended the hunt as "sustainable" because designated communities may kill a single Bowhead every other year (Nickerson 1998). With a population of only about 7,200 worldwide, and a low population in the Canadian Arctic, any take might be more than the species can sustain. Moreover, the meat and blubber are laden with highly toxic chemicals (see below). Should the Inuit choose to let the Bowhead Whales increase without killing any of these extremely rare animals, they might come to realize that certain ancient traditions can be left behind without harming their culture.

Our knowledge of whales is only fragmentary, a science in its early stages. Research investigations are only gradually accumulating crucial data. Yet in 1974, effective in 1975, the IWC adopted the so-called "New Management Procedure" (NMP), under which whale populations were allowed to be reduced to 54 percent of their estimated original numbers. Changed somewhat, it became the "Revised Management Procedure" in the 1980s. This highly simplistic procedure is based on a lack of scientific data, including inaccurate estimates of populations and inadequate information about whale reproductive biology. Whale numbers are estimated by research vessels counting whales seen to surface, in itself a highly unscientific method resulting in "ball park" or vague estimates. First, whales spend only about 5 percent of their time on the surface. Second, estimates of original numbers, a crucial aspect to this approach, are based on records of whales killed, with guesses as to what percentage of the population these represented. Third, in order to understand the population biology of a species--its longevity, rate of reproduction, natural mortality rate, differences in survival between populations, diet, and behavior--other aspects of its life history must be known. This crucial information is lacking for every species of large whale.

A dramatic illustration of the inaccuracy of whale population estimates is that of Norway's whaling of North Atlantic Minke Whales. Norway killed an average of 3,500 Minkes a year in the North Atlantic in the mid-1950s, before cutting back to 1,800 a year until 1983 (Chadwick 2001). In Antarctic waters, Russian and Japanese whalers killed 65,000 between 1971 and 1981 (Chadwick 2001). In 1986, the year the moratorium on commercial whaling became effective, Norway, along with Japan, Peru, the U.S.S.R. and Iceland, filed objections (Bright 1991). IWC members may defy regulations merely by filing such objections. Norwegian whalers killed 383 Minke Whales in 1986 and 375 in 1987; in 1988 Norway announced it would kill whales for scientific research, which is allowed by IWC (Bright 1991).

For several years, Norway killed small numbers of whales for "scientific research" but, in 1992, resumed killing large numbers of these whales. The population estimate upon which they based their self-imposed quotas was 86,700 Minke Whales in the North Atlantic. On this basis, it killed 301 whales. Scientific estimates later revised the population number to 69,600--an enormous difference of 17,100 whales. Norway then lowered its own quota to 232, which the IWC's Scientific Committee believed to be still too high. To its credit, the IWC denounced the whaling and, at its annual meeting in 1995, passed a strongly worded Resolution against Norway. Not only did Norway begin commercial whaling in defiance of IWC resolutions, but attempts were made to smuggle the meat--mislabeled--to Japan. This scheme was uncovered, and even this blot on Norway's international reputation did not result in a change of heart regarding this slaughter. In January 2001, Norway announced that it would openly sell whale meat and blubber to Japan, breaking a long-time agreement with the United States against international sale of whale products. Japan and Norway, recently supported by Iceland, have unsuccessfully petitioned the IWC to lift the moratorium on commercial whaling and allow Minke Whales to be hunted and have attempted to ease CITES restrictions that list the species on Appendix I, banning commercial trade, also without success.

How the IWC can arrive at <u>any</u> quota on Minke Whales is beyond reason, since almost nothing is known about Minke Whales--not even where they mate or calve (Chadwick 2001). These elaborate population estimates are obviously totally unscientific. Minke Whales have no distinguishing characteristics that might allow them to be identified as individuals as is the case with Humpback and Right Whales. Humpback Whales have a great variety of

black and white patterns on their tails, and no two are exactly alike. Northern Right Whales have callosities of various parasites, such as crustaceans, different with each whale. More than a decade has been spent by researchers working to document these individuals in the northwest Atlantic and enter the information into a database. No such research is possible as a means of counting Minke Whales.

The Long Battle for the Whales: Page 2

Off the coast of Scotland, where Minke Whales are protected, they approach boats and lift their heads above water, eyeing the boat and its occupants (Chadwick 2001). They have been seen leaping out of the water in apparent games that went on for more than an hour. Recently one was rescued after stranding on rocks. The Scottish rescuer said: "Off it went until it was almost out of sight. Then it returned. We were worried it would go onto the shore. But it swam away, and we decided the animal just came back to say thanks and cheerio. That's when we started to worry the poor thing might be going to Norway next" (Chadwick 2001). These whales have been swimming around boats and scuba divers along the Great Barrier Reef since the early 1980s, and some ecotours offer Minke-watching (Chadwick 2001). Some of these whales stay close to boats and divers for up to 11 hours, and while they seem silent in northern waters where they are killed, here they communicate in grunts, growls and "boi-oi-oings" (Chadwick 2001).

Whales have shown friendliness toward one another as well as toward humans who dive with them. An encounter between Blue Whales in the 1970s was witnessed by researchers on a vessel off the eastern Canadian coast. They spotted four Blue Whales: "Two pairs of whales coming from opposite directions met, churning the water as they rolled and dove about one another in what seemed, to human eyes, a tumultuous greeting. During the commotion one of the whales breached a third of its length . . ." (Vontobel 1975). This must have been a truly unforgettable sight and an indication that these whales communicate and form bonds with one another. Within the past decade, Blue Whales have increased somewhat. In the Pacific, they have recently begun congregating in or near a marine sanctuary off California's Santa Barbara Islands, where scientists from the National Oceanic and Atmospheric Administration (NOAA) are studying them. Almost 2,000 whales are regularly seen here, creating excitement for whale watchers and scientists alike.

The Long Battle for the Whales: Page 3

As one of the wealthiest countries in the world, Norway has profited from rich offshore oil reserves, and has a highly educated, liberal society. As the world's second largest oil exporter, it earns so much revenue that the government has been setting aside about $8.2 billion a year (AP 1997). It does not have an economic need for whaling income. The Prime Minister who first endorsed Norwegian whaling, Gro Brundtland, was known as a "Green" world leader, preaching environmental concern and backing strong national legislation to preserve Norway's environment. As a conserver of marine life, however, Norway has recently proven to be wasteful and destructive. Its centuries-old fishery has collapsed, putting thousands of employees out of work, and causing resentment among a population dependent on Atlantic Cod as a dietary and economic mainstay.

As a totally flawed and specious argument, Norway explained its return to whaling by stating it was needed to allow cod to recover. A 1990 report by the Norwegian Fisheries Ministry concluded that the Atlantic Cod catch would jump 5.6 percent the year following a kill of 1,700 Minke Whales, and higher employment would result (Bright 1991). Other Norwegian researchers have suggested that causing actual *extinctions* of marine mammals would increase fisheries value by 150 percent! (Bright 1991). Olaf Flaaten, a Norwegian professor who advised Brundtland, described marine mammals in 1988 as "vermin," causing great losses of fishes, citing Minke Whales and Harp Seals as the worst offenders. Apparently, Norway has been conducting control operations of marine mammals for some

time. At least 60,000 Harp Seals died in Norwegian fish nets in 1987, taken intentionally (Bright 1991). A Norwegian seal hunt killed 14,000 seals in 1989, and Harp Seal populations in the Barents Sea have been halved since the early 1980s (Bright 1991). Scientists from the IWC and the National Marine Fisheries Service (NMFS) have called the theory that fish populations will be increased by killing marine mammals totally baseless (Bright 1991). The underlying cause of the fisheries collapse is overfishing of Atlantic Cod and other fish and their prey, Capelin and Atlantic Herring. In 1996, 10 tons of whale meat were allegedly smuggled from Norway to Japan, and the same year, Norway announced that it would increase the kill of North Atlantic Minke Whales to 425, almost double 1995's catch. Minke Whale meat is sold in Norwegian markets, and the country plans to begin exporting it--in defiance of CITES--to other countries that have taken reservations on whale listings (Chadwick 2001).

The views of Norwegians who endorse slaughter of marine mammals may not reflect the consensus of the Norwegian public. In 1995 a Norwegian newspaper, *Oslo Arbeiderbladet*, representing the Prime Minister's own Labor Party, editorialized: "The Norwegian battle to gain international acceptance for whaling is already lost. The sooner we realize this, the better. The only argument that could be used to defend the whaling, namely that the science is on our side, is no longer valid. The so-called 'secure' figures of Norway were shown to be based on wrong figures and mistakes in the data programs." The editorial concluded that Norway must stop whaling if it wishes to be taken seriously as an environmentally concerned nation. Some Norwegian whalers, however, claim that whaling does not differ from cod or herring fishing, and that whales are just "big mountains of meat" (Gibbs 1997).

The United States chose not to punish Norway for its illegal whaling. In Section 8 of the U.S. Fisherman's Protective Act, the "Pelly Amendment" permits the President to embargo any and all fisheries products from countries whose nationals have engaged in taking a marine resource in such a manner as to "diminish the effectiveness of an international fishery conservation program." In 1979, an additional sanction was voted into law, the Packwood-Magnuson Amendment. This amends the Fishery Conservation and Management Act to cut fish allocations by half on certification by the Secretary of Commerce that a nation has violated the provisions of the Pelly Amendment. If a nation persists, all fishing rights are canceled. For Norway, its exports of fisheries products to the United States are considerable, amounting to more than $140 million each year. The Secretary of Commerce took the initial action of certifying Norway under the Pelly Amendment, but President Bill Clinton chose not to place an embargo on its fishery exports to the United States. In a letter to Congress in October 1993, President Clinton said the United States™ objectives could best to achieved by "delaying the implementation of sanctions until we have exhausted all good-faith efforts to persuade Norway to follow agreed conservation measures." Prime Minister Brundtland came to the United States and successfully lobbied to prevent economic sanctions against Norway. Before leaving office in 2001, President Clinton decided not to impose import restrictions on Japan under the Pelly Amendment for expanding its "scientific" whaling to include Bryde™s and Sperm Whales.

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Traditionally, the United States has maintained a strong anti-whaling stance and has been a major force in bringing about reductions in whaling quotas and the 1982 moratorium. Japan and Norway, however, are now whaling without any basis on sound science, and in violation of the spirit of the moratorium. Iceland is planning to reenter commercial whaling as well. Japan's high take of Minkes in Antarctic waters violates the 1994 sanctuary designation of the seas surrounding Antarctica (Chadwick 2001). To open markets worldwide to many types of whales, Japan has presented numerous proposals to downlist whales on CITES: two would have placed North Pacific and Southern Hemisphere stocks of the Minke Whale on Appendix II, one would have transferred eastern Pacific stock of the Gray Whale to Appendix II, and one would have downlisted the northwestern Pacific stock of Bryde's Whales from Appendix I to II. Bryde™s whales occur in all the world's oceans.

Japan has also continued its "scientific" whaling and announced in November 1994 that it would begin selling 65

tons of meat from Minke whales caught in the northwest Pacific. In an eight-year period from 1980 onward, Japan killed 28,818 Minke whales, and it has also imported enormous amounts of whale meat--123,955 tons between 1980 and 1991 (Chan *et al*. 1995a). This country provides the world's largest retail market for whale meat, buying illegally caught meat from pirate whalers around the world. A recent AWI-supported investigation by Steven Galster and Rebecca Chen (1994) uncovered enormous caches of illegal whale meat stockpiles held in Russia for eventual sale to Japan; 232 metric tons were found in Vladivostok alone, including thousands of pounds of meat from Bryde's Whales. This 50-foot species has been on Appendix I since the 1970s, and the illegal meat was being smuggled from Taiwan to South Korea and then to Japan. The latter smuggling operation began in 1988 and continued until at least 1994 (Galster and Chen 1994). Investigators found Bryde's Whales™ skin and fat being openly sold in a Japanese shop in 1995 (Chan *et al*. 1995a). Yet Japan claims it has legal stocks of frozen Sei, Fin, Bryde's and Sperm Whale meat (Chan *et al*. 1995a). Similar studies in the intervening years have determined that, based on DNA studies of whale meat sold in Japan, protected and endangered whales, including the Blue Whale, are still sold in Tokyo (ABC News, July 14, 2001).

Japanese and American toxicologists have also analyzed whale and dolphin meat and found extremely high levels of heavy metals (such as mercury) and toxic chemicals (such as dioxin and PCBs)--high enough to pose a serious health threat merely by eating a few ounces of blubber (Chadwick 2001). A study in the Faroe Islands north of Scotland found brain and heart damage in children whose mothers had eaten whale meat (Chadwick 2001).

Japanese national legislation does not cover the regulation of all whale meat sales, and it retails at an average of $64 per pound. In 1993 Japan enacted legislation that prohibited the capture, possession or sale of Blue and Bowhead Whales without a permit issued by the Minister of Agriculture, Forestry and Fisheries. However, this is not meaningful legislation since the Blue Whale has been legally protected from killing and international trade for decades, and Bowhead Whale meat can only be consumed by the native peoples who kill them. In another recent investigation by two scientists working for Earthtrust, DNA analyses were conducted on whale meat being sold in Japan. This sophisticated forensic study determined that the meat came from Humpback, Fin, and North Atlantic Minke Whale (AWI 1994). Humpback and Fin Whales are endangered species, and the revelation of this trade should have resulted in international sanctions, but it did not.

In 1996, the U.S. Secretary of Commerce formally certified Japan under the Pelly Amendment for outlaw whaling. Japan™s continued defiance of the IWC by granting itself "Scientific Permits" for research represents a lack of compliance with international treaties. An IWC Resolution recommended that scientific whaling be non-lethal. Yet in 1996, Japan announced that it increased the quota its ships can kill in the Antarctic from 330 to 440 Minke Whales, and continued to kill 100 whales in the north Pacific (Kristof 1996). At the 1996 IWC meeting, a Resolution was passed requesting Japan to halt its scientific whaling, in particular in the Southern Ocean Sanctuary, and Japan's request for 50 Minke Whales from the North Pacific was turned down for the ninth year in succession. Although the Pelly Amendment allows trade sanctions on the enormous quantities of fisheries products that are imported into the United States, President Clinton announced on February 9, 1996, that he would not impose any penalty on Japan. The Animal Welfare Institute, through full-page newspaper advertisements and mailings, opposed the illegal whaling of both Japan and Norway, urging boycotts of products and services from these countries.

South Korea and Taiwan, while not permitting whaling, have shipped illegal whale meat to Japan. In 1993, South Korea received 3.5 tons of Minke Whale meat being smuggled from Norway, and one of its freighters was caught smuggling whale meat into Japan in 1994 (Chan *et al*. 1995a). Investigators found baleen whale meat and dolphin for sale in a vast fish market in Pusan, South Korea, in April 1995 (Chan *et al*. 1995a). Taiwan exported 14,590 boxes of whale meat to Singapore in 1993, and it is suspected of laundering illegal whale meat (Chan *et al*. 1995a).

The United States and other countries are under pressure to agree to a return to commercial whaling should whale populations increase. The IWC's "Revised Management Procedure" would authorize the slaughter. Estimates of a very large population of between 510,000 and 1.4 million Minke Whales in the Southern Hemisphere have proven to be too high, yet the IWC's Scientific Committee has approved a management plan that would permit the killing of

5,000 to 10,000 of these whales a year (Chadwick 2001). Japan's request for a Scientific Permit to kill Bryde's and Sperm Whales was turned down by the IWC in 2000, but it proceeded to take five Sperm Whales, 43 Bryde's Whales and 40 Minke Whales in a hunt in the North Pacific during that same summer. The same year, its proposals to downlist this species from Appendix I at the CITES Conference also failed. In the fall of 2000, Japanese whalers sailed to Antarctica for a five-month "research" trip, with plans to harvest up to 440 Minke Whales (Chadwick 2000). Both the IWC and CITES lack any enforcement powers, and the effectiveness of these Treaties depends on national legislation. For this reason, whalers have flouted regulations by killing protected whales for decades, with little fear of retribution. The Environmental Investigation Agency (EIA) compiled a list of known violations by whalers since 1942, involving thousands of rare and endangered whales to illustrate this (AWI 1995). Those countries and organizations that believe in a return to commercial whaling support a cold-blooded approach to whales that does not recognize their intelligence, friendliness, and the lack of information on the extreme stresses they endure from other threats, including: pollution by toxic chemicals; ozone depletion that is destroying phytoplankton, which is the basis of marine food chains; collisions with ships; entanglements in fishing nets; and coastal development, to name just a few.

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To end whaling and trade, economic alternatives such as whale watching should be seriously considered by those countries that continue to whale. Even Japan has recently begun whale watching tours in the Ogasawara Islands, bringing in sizeable revenues. One Japanese fishermen said: "Whales have always been regarded as a kind of divine omen in this area. I feel it is an atrocious thing to kill whales. We Japanese do not have to eat whales anymore" (Anon. 1992). In 1992, an estimated 19,267 people participated in whale watching in Japan, a $10 million business according to *New Scientist* (May 8, 1993), which also reports that Japanese people are increasingly critical of their government's whaling. In 1996, anti-whaling pressures increased within Japan, and many young Japanese now consider the whale a mammal rather than a meal, but this has not influenced the government's policies (Kristof 1996). A Japanese harpooner quoted in *The New York Times* angrily disputed critics of whaling, saying: "I don't think of whales as especially smart. They're just like ordinary fish. We feel that they're just a big present from the sea" (Kristof 1996). Most Japanese are unaware that Japan is still involved in whaling (Kristof 1996).

In the United States, almost $200 million was earned by whale watching boats and associated businesses in 1991 (WDCS 1991). In 1992, revenues from the whale watching industry increased to $260 million, and a survey found that whale watching was carried out in 37 countries (*New Scientist*, 8 May 1993). By 1998, the worldwide total revenues from whale watching topped $1 billion, according to a study by the International Fund for Animal Welfare (IFAW). This far exceeds revenues from whaling (BG 2000). Nine million people whale watched in 1998 in 87 countries, according to the IFAW study. The sale of whale meat represents a one-time profit, as opposed to the renewable benefits from watching whales that may live to be 50 or more years old. An adult Minke Whale brings about $100,000 on the market (Talmadge 2000)--a significant amount, but a fraction of its potential income from whale watching. Products obtained from whales are not essential, and economically, far more people profit from whale watching than from the whale products industry. They include whale watching boat companies, local motels and restaurants and tourist shops. By contrast, whaling profits the whaler, the wholesale buyer and the retail seller. These arguments should not be necessary, however, in view of the extraordinary qualities of these fascinating animals. Whales possess tremendous appeal, and the research that will reveal the most about them will be based on observations of live whales, not necropsies of dead ones.

A growing number of people condemn the killing of all cetaceans. Iceland's illegal whaling in the late 1980s was halted when conservation and humane organizations persuaded many commercial importers of Icelandic fish to cancel orders, costing that country some $50 million. The actions of governments, individuals, organizations and consumer boycotts, combined with public opinion, have brought about whaling moratoriums and country bans. Only stronger

enforcement of laws and better public awareness in the whaling countries themselves about the cruelty to these gentle and intelligent creatures may bring whaling to an end. The presence of these sentient beings in the ocean is an inspiration to all, but their survival may depend on active opposition to their killing.

Dolphin and Small Cetacean Fisheries

The killing of dolphins and Pilot Whales is not covered by the IWC regulations, and as restrictions on killing the great whales increase, some countries are turning to small cetaceans. The true extent of dolphin killing around the world is not known but is presumed to be well over 100,000 animals per year, with more than 60 species subject to commercial harvest. Sri Lanka, Turkey and other countries have unregulated--but considerable--dolphin fisheries. No international treaties cover this slaughter other than CITES, which lists some dolphins and porpoises on Appendix I, banning trade, and the rest on Appendix II, which regulates it. The fisheries may be endangering numerous species and eliminating local populations. Japanese fishermen are killing Dall's Porpoises (*Phocoenoides dalli*) in large numbers. These porpoises are known to "bow-ride" in the wake of their small dories. Taking advantage of this apparent dolphin game, fishermen are harpooning the frolicking dolphins in their backs with steel-barbed weapons, causing a painful and slow death. The meat is then marketed as "whale." At least 560 boats are killing these small black-and-white porpoises off the Japanese coast (Currey 1990). Approximately 111,500 of these porpoises were killed by Japan from 1986 to 1989 (Nowak 1999). In 1990, the IWC passed a Resolution calling for a reduction in the number of Dall's Porpoises killed to at least 10,000, but Japan killed 17,634 the following year (Chan *et al*. 1995a). The Japanese continue this killing, using 80 fishing boats that pursue migrating herds throughout the year. An estimated 67 percent of Dall's Porpoises have been killed by the Japanese, who killed 65,159 of these porpoises between 1990 and 1993 (Chan *et al*. 1995a). Annual kill is now about 20,000 and seems to involve mainly immature animals (Nowak 1999). The *2000 IUCN Red List of Threatened Species* lists this species as Conservation Dependent, in spite of the fact that there seems to be little conservation preserving this species.

Striped Dolphins (*Stenella coeruleoalba*) have been nearly eliminated along the Japanese coast (Currey 1990). Recent statistics from the IWC show that Japan whales 18 species of small cetaceans, and kills many thousands more as incidental catch in its fisheries (Chan *et al*. 1995a). The 76,295 of these dolphins killed directly make up only a portion of their human-caused mortality; added to this, 35,002 Striped Dolphins drowned in fishing nets, for a total of 111,297 killed between 1990 and 1993 (Chan *et al*. 1995a). The combined killing from these two causes is resulting in declines. It, too, is listed as Conservation Dependent by the *2000 IUCN Red List of Threatened Species*.

When Atlantic Pilot Whales (*Globicephala melaena*) gather in the bays of the Faroe Islands of the North Atlantic, as they probably have for thousands of years, they encounter local fishermen, who herd them toward the shore in small boats. Others wade into the water and kill the friendly animals with hooked fishing gaffs--perhaps the cruelest of all the whaling methods. Some use large meat cleavers to literally saw off the Pilot Whales' heads, while the animal writhes in the shallow water. The Faroese people consider this annual slaughter a "sport" and even encourage very young children to participate. Years of campaigning by groups such as the Environmental Investigation Agency, which has filmed the hunt in all its gore and shown wounded animals dying slow deaths, have failed to stop it. In spite of their name, Pilot Whales are actually closely related to dolphins and are social, forming very close-knit clans in which only a few young are born each year. The entire herd cares for the young. DNA analyses of animals killed in the Faroe Islands showed that all members of individual groups are related to one another. These herds are led by older females, who are the repositories of learned information about food sources and other survival lore (Harrison and Bryden 1988). This partly explains why they follow one another when one becomes stranded and keep returning to the beach if turned back to sea.

Chilean fishermen kill thousands of Commerson's Dolphins (*Cephalorhynchus commersonii*) to use their meat as crab bait. These small dolphins resemble miniature Killer Whales (*Orcinus orca*) with their black-and-white

coloration, although their body form is similar to that of Harbor Porpoises. Only about 4.8 feet long, these dolphins are found only in the Southern Hemisphere from Argentina south to the Kerguelen Islands (Harrison and Bryden 1988). So many have been killed that their population has declined precipitously. A closely related species, Hector's Dolphin (*Cephalorhynchus hectori*), native to New Zealand waters, has declined from pollution and trawling, which drowns thousands. The New Zealand government banned trawling within a 1,170-square- kilometer area where the species congregates. Its status has become more endangered in the past four years, and the IUCN raised its status from Vulnerable in 1996 to Endangered in 2000.

Russia announced early in 1997 that it is considering a return to commercial whaling, targeting Belugas, or White Whales (*Delphinapterus leucas*). They claim that these whales are depleting cod stocks in the White Sea, echoing the unscientific claims of Norway's scientists. These small whales have declined in many parts of their ranges. In the Arctic, Belugas swim in small groups, using their sophisticated echolocation system to navigate and locate fish in this frozen environment (Harrison and Bryden 1988). They have extremely flexible bodies, enabling them to rotate their flippers and heads, to twist their bodies around, and even to swim backwards using their flukes (Harrison and Bryden 1988). Recent research on captive Belugas at the Shedd Aquarium in Chicago has revealed them to be talented mimics, able to imitate a great variety of sounds (Yovich 1996). In one case, Belugas in a tank next to another tank used to train a dolphin with a low-frequency tone, began making the identical sound, which was a signal for the dolphin to swim away. Researchers were at first confounded when the dolphin would swim away before they gave her the tone sound, only to find out that the Belugas were mimicking it, either out of mischief or as a normal behavior (Yovich 1996). Their talents at mimicry extend to imitating whistles, human-produced sounds, bird calls, fire alarms, and scuba regulator sounds, among others (Yovich 1996). Research on the use of this talent by wild Belugas is now beginning.

There are separate populations of Belugas in the Arctic region, and several of these are in steep decline: the Cumberland Sound population has declined to only about 600 animals; and the St. Lawrence Belugas have declined from 10,000 to only 350 animals, decimated by the effects of pollution from factories (Nowak 1999). They are now so contaminated that their bodies constitute hazardous waste. These beautiful whales are hunted in Canada and Greenland by natives in a totally unmonitored fashion, with only fragmentary knowledge of their life history. Some populations have been reduced 20 percent by hunting (Darling *et al*. 1995), and for the first time, the IUCN listed this species in the Vulnerable category in its *1996 Red List of Threatened Animals* (Baillie and Groombridge 1996). The *2000 IUCN Red List of Threatened Species* also listed the species as Vulnerable. Worldwide populations have declined from 250,000 in 1965 to between 100,000 and 150,000 in 1996 (Yovich 1996), with the lower figure considered more likely (Nowak 1999).

Small cetaceans have incurred major declines from direct and indirect killing. Dolphins and porpoises have only one calf per year, and for some species, many adults are non-breeding members of the herd. Unrestricted hunting has the potential to endanger many species, and international controls are needed. Many species and populations of dolphins continue to drown in large numbers in tuna purse seine nets, and pollution has killed a large percentage of the Atlantic, North Sea and Mediterranean dolphins in the past decade. The number of threatened and possibly threatened small, saltwater cetaceans has grown from 35 species listed in the *1996 IUCN Red List* to 47 species, almost all in the category Data Deficient, indicating that more information is needed about their status, which might show the species to be threatened. It is an indication of the lack of conservation attention these species have received that so many are listed in this category. Obviously, much more research is needed. Dolphins and porpoises have captured our imaginations after many true stories of their having saved people from drowning and their role in the mythology of the Greeks and others. It is incumbent on us to maintain the diversity of these small cetaceans and prevent them from declining to endangered status or disappearing altogether.

Fur: A History of Endangering Species

The history of the fur trade, past and present, is evidence that no animal, no matter how abundant, is immune to possible extinction should its pelt become valuable to the fur trade. A pattern develops as fur pelt prices rise, and the species becomes rare from overtrapping. These pelts become more avidly sought out. Commercial extinction can result fairly quickly if animals with valuable pelts are killed at a rate greater than they can reproduce. Animals whose populations numbered in the millions and whose ranges extended over entire continents have been reduced to near extinction within the space of a few decades, as demonstrated by the trade in spotted cats. For those animals that are naturally rare in the wild, or rare due to ecological or geographical reasons--the Falkland Island Wolf (*Dusicyon australis*), the North American Sea Mink (*Mustela macrodon*) and the Rufous Gazelle (*Gazella rufina*), for example--extinction came quickly when their pelts were in demand by the fur trade.

Extinctions

The Falkland Island Wolf was an extremely tame and fox-like wolf about 3 feet in length, with a short bushy tail 11 inches long (Nowak 1999). This brown canid had a large skull with a short nose, broad muzzle and small ears. It was the only land mammal native to these subantarctic islands, and it lived on birds, especially geese and penguins (Nowak 1999). How these wolves arrived on the islands, which are 400 kilometers from the mainland, is not known, but in prehistoric times, natives may have brought them as domestic animals. Another theory is that sea levels during the Pleistocene might have been low enough to permit their migration from South America (Nowak 1999).

Charles Darwin, on his voyage in the Beagle, collected three skin specimens of the Falkland Island Wolf, two of which were presented to the London Zoological Society (Day 1981). Darwin found these animals very common and tame during his visit in 1833. They approached visitors to the islands out of apparent curiosity (Day 1981). According to some accounts, they even came to campsites and carried away supplies (Nowak 1999). The Falkland Island Wolf was exploited by fur trappers shortly after British settlement of the islands in 1800 (Allen 1942). The American fur magnate, John Jacob Astor, sent men in 1839 to collect pelts, and great numbers were taken; others were poisoned by sheep farmers. Darwin noted that they were so easily killed that men could hold out a piece of meat in one hand and stab the animal with a knife held in the other when it came within reach (Day 1981). By 1870, they had become very rare, and the last individual of this species was killed in 1876 (Allen 1942).

The Sea Mink of the coasts of northeastern North America was another casualty of the fur trade. Its brutal extinction was described in Chapter One. Both this species and the Falkland Island Wolf had very limited distributions, making their populations vulnerable to overexploitation. Also, both were the objects of intensive hunts for their furs. Only the very large distributions of some species whose populations were reduced to near-extinction, such as the large spotted cats and many species of otters, saved them from the same fate as the Falkland Island Wolf and Sea Mink.

A beautiful and delicate animal of North African forests, the Rufous Gazelle, was also killed for its pelt. One of the largest gazelle species, it was 5 feet long, with foot-long spiraled horns (Day 1981). Little is known of this species other than sightings of small groups of gazelles in the mountainous forests above the Chelif valley of Algeria. The only people who were familiar with the Rufous Gazelle were furriers of Oran who saw it as a rare and costly pelt that they acquired every three or four years in the 1920s (Day 1981). These delicate, reddish gazelles disappeared during this period and, by the 1940s, were considered extinct. Three specimens were taken by museums (Day 1981).

Prior to the 20th century, a long list of furbearers were nearly eliminated by the fur and hide trade. In North America, the Bison, Beaver, River and Sea Otters, Marten, Fisher and Kit Fox, disappeared from most of the continent by the end of the 19th century. Today, the Beaver has made a comeback, largely as a result of reintroduction, but the other species have greatly reduced distributions and numbers.

The international fur trade's beginnings in the 18th century endangered one species after another and continued unabated through the 19th century. This period marked the most extensive wildlife slaughter in recorded history. Vast numbers of wild animals which roamed continents and swam ocean waters were reduced to scattered remnants. Heavy fur trading continued into the 20th century. During the 1920s, U.S. sales peaked at more than 50 million wild animal pelts (Osborn and Anthony 1922). The fur trade soon discovered new species to replace those overharvested.

Trapping of fur animals involves extreme cruelty. One of the most widely used traps to take fur animals throughout the world is the wire snare. Loops of strong wire are designed to tighten until they cut through skin and organs. Leg snares are placed on the ground, and the animal walks into the loop, which then springs and tightens on the leg. Sometimes the animal is caught by other parts of the body and dies slowly. Neck snares, set higher up on tree trunks, are intended to grab the animal by the neck and strangle it. In tropical countries, these snares have been responsible for the agonizing deaths of hundreds of thousands of wild cats, antelope, primates, and perhaps an equal number of non-target animals. Elephants have blundered into neck snares and become entrapped by a leg--or even the trunk--and died slowly of infection after weeks of pain. These snares are totally non-selective, and present a major threat to virtually all mammals and many other types of animals, even in national parks. In Africa, Leopards, civets, and Cheetah are among intended victims snared and often found severely wounded. Wire snares are legal in many U.S. states, although they have been banned in some.

Trapping methods in North America, which produces the largest number of wild furs in the world, have changed little since the 18th century. The steel jaw leghold trap, used to obtain the majority of these wild fur pelts, is extremely inhumane. Holding the animal's paw or leg tightly, it usually cuts off circulation, and it often breaks bones. Many animals are so frantic to escape that they chew off their own trapped paws. These traps were decried by Darwin in an article in the *Gardeners' Chronicle and Agricultural Gazette* of August 1863. Darwin described the suffering of animals caught in these traps, "We must fancy what it would be to have a limb crushed during a whole long night, between the iron teeth of a trap, and with the agony increased by constant attempts to escape." He spoke of rabbits, still alive when the trap was approached, who started up, struggling violently to escape, "shrieking pitiably from terror and the pangs occasioned by their struggles." Darwin pleaded for a ban on these traps, but it was not enacted in England until the 1950s.

Trappers in many U.S. states and Canadian provinces do not have to check their traps for days on end; and in Alaska, Michigan, North Dakota and Montana, there is no time limit for trap-checking. The trapped animal suffers pain, trauma, hunger and thirst. There are even cases of trappers failing to return to check traps until the snow cover melted, revealing animals that had taken weeks to die. Gangrene and fatal infections result from injuries received in these traps to animals, such as pets, that had been trapped for long periods. Thousands of non-target animals, many of these endangered species, are caught in leghold traps every year. The AWI publication, *Facts About Furs*, discusses this and other traps and provides photographic documentation of the suffering animals endure to become fur coats. In 1994, the World Veterinary Association declared the leghold trap to be inhumane, and many other veterinary organizations, including the American Animal Hospital Association (AAHA) and the American Veterinary Medical Association (AVMA), have condemned it. The steel jaw leghold trap has been banned in 88 countries, including all European Union countries; but these traps are officially endorsed by U.S. and Canadian wildlife agencies, both federal and regional. Some U.S. states have restricted or banned use of the steel jaw leghold trap, and in several states, all lethal traps have been banned by voters through Referendums that bypassed state legislatures, which tend to support these traps and refuse to allow votes on their prohibition. New Jersey bans sale, possession and use of steel jaw leghold traps. California, Colorado, Florida, Massachusetts, Rhode Island and Washington prohibit their use (with exceptions under special circumstances). In Arizona, these traps are banned on public land (80 percent of land in Arizona is public), with exceptions permitted to protect public health and safety.

Fur Seals

The 18th and 19th centuries saw a massive slaughter of fur seals wherever they were found, from the Aleutian Islands to the Antarctic and shores and islands of all the major continents. These animals are especially vulnerable when on land, breeding and having their young, as they are slow and ponderous and can easily be blocked from entering the sea and being bludgeoned. Hundreds of thousands of fur seals lined coasts and off islands in cold water areas throughout the world. The Northern Fur Seal (*Callorhinus ursinus*) inhabits the North Pacific from the Channel Islands off California in a large arc to the Sea of Japan (Nowak 1999). Estimated to number 4.5 million in 1870, sealing reduced them to 200,000 by 1914 (Sparks 1992). Pelagic sealing had a catastrophic effect on these seals; more than 1 million Northern Fur Seals, of which 60 to 80 percent were females, were taken at sea from 1868 to 1911 (Nowak 1999). Many of the females were lactating and had left their pups on land while they foraged at sea. Major conflicts erupted between the countries where the rookeries were located, Russia and the United States, and the two major pelagic sealing nations, Canada and Japan (Nowak 1999). The situation was resolved when the fur seal rookeries on the Kuril, Commander and Robben Islands in the western Pacific were almost completely eliminated (Nowak 1999).

Pelagic sealing was banned by treaty in 1911, but commercial harvests on the Northern Fur Seal's breeding islands did not stop until the 1980s, when the species became depleted. This seal also suffers from a mortality of some 50,000 a year drowning in driftnets (Nowak 1999). When the regulated kill in Alaska was stopped, it was expected that the species would rebound, but numbers of pups born dropped on the Pribilof Islands from 450,000 in the mid-1950s to 253,000 in 1992, and the species population there is half what it was in the 1950s (Nowak 1999). The National Marine Fisheries Service, which has jurisdiction over marine mammals, designated it a depleted species but refused a petition to list it on the U.S. Endangered Species Act. It is a species "undergoing its most serious crisis since the era of pelagic sealing a century ago" (Nowak 1999). The *2000 IUCN Red List of Threatened Species* lists it as Vulnerable, the category below Endangered, indicating a dangerous decline. The species spends much of the year in open sea, and there has been speculation that, in addition to losses from entanglements in fishing nets and gear, illegal killing for fur may be taking place by fishing and other vessels.

Three of the eight other species of fur seals are also listed as Vulnerable by the IUCN. They inhabit waters further south, from Guadalupe Island off Baja California, Mexico, to the Galapagos and Juan Fernandez Islands off South America. All originally had limited populations in restricted distributions and were heavily hunted for their fur. After a century of protection, they have not recovered their numbers, and were even thought extinct for a period. The Juan Fernandez Fur Seal (*Arctocephalus philippi*) is native to the islands made famous by Alejandro Selkirk, upon whom the novel *Robinson Crusoe* was based. Prior to any sealing, the species may have numbered 4 million; after 18th century sealers began exploiting them, they were quickly reduced to 2 to 3 million (Nowak 1999). Up to 3.5 million were taken from 1793 to 1807, with as many as 15 ships all killing seals at the same time (Nowak 1999). By 1824, the species was considered commercially extinct (Nowak 1999); it disappeared in 1891, considered extinct (Allen 1942). Small numbers were discovered in 1968 near Isla Robinson Crusoe, and a census in 1983-1984 counted 6,300 fur seals throughout the islands. Another count in 1990 estimated 12,000 Juan Fernandez Fur Seals, but there is some poaching and harassment by fishermen (Nowak 1999).

The Southern Fur Seal (*Arctocephalus australis*), native to the coast of South America, was also heavily exploited beginning in 1515 (Nowak 1999). Not until the 1940s was the killing controlled, but even with an authorized kill of about 12,000 seals a year, the population in Uruguay fell from 252,000 to 5,000 from 1987-1991, a precipitous drop (Nowak 1999). The species has not recovered from sealing and now numbers about 83,000 (Nowak 1999). Although its population is below that of the Northern Fur Seal, it is not listed as Vulnerable by the IUCN. Darwin saw these seals on Chiloe Island, off southern Chile. He described them in his notes on the epic voyage on the *Beagle:* "I

accompanied the Captain in a boat to the head of a deep creek. On the way the number of seals which we saw was quite astonishing: every bit of flat rock, and parts of the beach were covered with them. They appeared to be of a loving disposition, and lay huddled together, fast asleep . . .fl

The smallest fur seal is the Galapagos (*Arctocephalus galapagoensis*), with males weighing only 64 kilograms and females weighing 27 kilograms, (Nowak 1999). So heavily hunted by commercial sealers in the 19th century that it was thought extinct by the early 20th century, small populations were seen in 1932 (Nowak 1999). It has recovered to a population of 30,000 to 40,000. Although protected by Ecuadorian law in these islands, it is attacked by feral dogs (Nowak 1999) and, in view of the oil spill that took place in early 2001, is vulnerable to that threat as well.

The Guadalupe Fur Seal (*Arctocephalus townsendi*) was once found from Guadalupe Island off Mexico and along the coast of Baja California, Mexico, north to the Channel Islands, California. Originally numbering up to 200,000 seals on Guadalupe alone, thousands more lived along the coasts (Nowak 1999). Early in the 19th century, sealers killed the majority of the population, returning regularly to kill more seals until 1894 when no more could be found. It was twice considered extinct (1895 to 1926, 1928 to 1949) (Nowak 1999). Rediscovered on Guadalupe Island in 1926 by two fishermen, several seals were sent to the San Diego Zoo in 1928. After a quarrel between one of the fishermen who discovered the seals and the Director of the zoo, the former stormed off to Guadalupe Island in 1928 to kill the entire herd; he killed every seal he found and sold the skins in Panama, where he was killed in a barroom fight (Curry-Lindahl 1972). Not until 1949 was a lone male seen on Nicolas Island in the Channel Islands off southern California; in 1954, a small colony of 14 seals was found on Guadalupe Island, hiding in caves along the shore (Curry-Lindahl 1972). They were accorded protection by Mexico and, later, by the 1972 U.S. Marine Mammal Protection Act, but their populations have remained low. Several bulls of this species have been seen in the Channel Islands off California, but no breeding has been recorded there. The population on Guadalupe Island increased to about 1,600 by 1984 (Reeves *et al*. 1992) and to 7,000 in 2001 (Nowak 1999), a fraction of the original numbers.

Other fur seal species in South Africa, islands in the Antarctic region, New Zealand and Australia were also heavily hunted, nearly causing their extinctions. Exploitation of South African Fur Seals (*Arctocephalus pusillus*) began in 1610 and is still continuing. Their major population is along the southwestern coast of Africa, but they range as far as Australia, Tasmania and New Zealand (Nowak 1999). By the end of the 19th century, their populations along the coasts of Angola, Namibia and South Africa reached dangerously low levels, when sealing was curtailed (Nowak 1999). After increases in the 20th century, a large commercial harvest of 75,000 was authorized on a population estimated at 1.1 million (Nowak 1999). This species is the only fur seal still killed in a large, legal kill. In 2000, 60,000 were killed. Fishermen pressure the government to maintain this kill, claiming that the fur seals harm fish stocks, and fur dealers also exploit the seals for their pelts. The hunt in Namibia was filmed in 2000 and aired on CNN (Cable News Network), showing young male seals on shore being killed by men hitting them with heavy wooden bats. Activists are working to end this hunt, which is not humane. Ecological studies of their population status, food supply, persecution by fishermen, effects of the frequent oil spills that occur in this region, and other important factors affecting their populations have not been carried out. Populations in the Australia area numbered about 200,000 after several decades of sealing, and by the end of the 19th century, regulations limited the kill. The species gradually recovered to about 25,000 in the 1940s, and because of mortality from persecution by fishermen and drowning in nets, the population still only numbers about 30,000 to 50,000 (Nowak 1999). The New Zealand Fur Seal (*Arctocephalus forsteri*), which also inhabits coasts of Australia and Tasmania, was devastated by early sealing and has been slowly recovering. Originally numbering 1.5 to 2 million, they may number only about 27,000 at present (Nowak 1999). Along the Australian coast, they are strictly protected and now cluster in large numbers on the shore of Kangaroo Island, where boardwalks have been built above the rocks for tourists to see them.

Chinchillas

Chinchillas, native to the high Andes, have silky, gray fur, which became very popular in the fur trade in the late 19th century. These rodents were once abundant, and early explorers reported seeing hundreds in a single day (Nowak 1991). Somewhat larger than guinea pigs, chinchilla females are heavier than males, weighing up to 800 grams (28 ounces), while males weigh about 500 grams (17.5 ounces) (Nowak 1999). They are long-lived, with records of individuals surviving to be 20 years old and reproducing until the age of 15 (Nowak 1999). Pelt hunting intensified, with exports rising to an estimated 2 million pelts between 1895 and 1900 (IUCN 1994). In 1905 alone, 217,836 pelts were imported into the United States from South America (Poland 1892). These shy animals were relentlessly pursued when they became rare, and their skins rose to $200 per pelt; fur buyers gave instructions to agents to obtain pelts "at any price" (Allen 1942). Early in the 20th century, populations of both species--the Long-tailed (*Chinchilla laniger*) and the Short-tailed (*Chinchilla brevicaudata*) Chinchilla, collapsed. In 1910, an agreement was signed by Andean countries where the two chinchilla species occur, to prohibit capture, trade and export (IUCN 1994). Once found throughout the Andes in Peru, Chile, Bolivia and Argentina, chinchillas remain highly endangered. A wild chinchilla coat sold for $49,000 in Japan in 1981, and others have sold for as much as $100,000 (Nowak 1999).

Wild populations of both species are now listed on CITES Appendix I, banning commercial trade. The Long-tailed Chinchilla is restricted to the Cordillera de la Costa and the Andean slopes of Chile; it has an estimated population of 5,500 in Las Chinchillas National Reserve and may occur outside the reserve (IUCN 1994). The Short-tailed Chinchilla once had the wider distribution of the two, extending from the mountains of Bolivia and Peru through Chile to northwestern Argentina, but information indicates that it is extinct in Peru and Argentina and is close to extinction in Chile and Bolivia (Thornback and Jenkins 1982; IUCN 1994). In fact, there are no recent records of the species in Lauca National Park in northern Chile, where it had previously been thought to occur, and Short-tailed Chinchillas have never been recorded in the adjoining Sajama National Park in Bolivia (Thornback and Jenkins 1982). Attempts have been made to introduce chinchillas into the wild, but without success to date (Nowak 1999).

As early as 1900, chinchillas were taken into captivity to breed for the fur trade. The International Fur Trade Federation estimates that 200,000 chinchilla pelts are produced annually, with the United States breeding the largest number; pelts sell for up to $98 (IUCN 1994). Japan is the major market for this fur, followed by South Korea and China (IUCN 1994). The domesticated animals have been bred into different sizes and colors; they are larger than the wild species, with pelt colors ranging from gray and brown to various pastel shades (IUCN 1994). In 1994, films of genital electrocution taken on chinchilla farms resulted in a Sonoma Valley, California, farm being charged with cruelty to animals. Prosecutors documented that, according to veterinarians, the animals suffer during this process, in which the chinchilla is held upside down by the tail and electrodes are placed in the ear and in the anal canal or penis; a switch is then pulled to electrocute. According to guidelines established by the American Veterinary Medical Association, such euthanasia should be carried out only on unconscious animals.

Since ranched pelts are considered superior to wild ones, fur dealers have stated that no demand exists for wild chinchilla fur, and the government of Chile successfully proposed in 1994 that domesticated chinchillas and their fur not be covered by CITES Appendices. The *IUCN Mammal Red Data Book* stated, however, that "hunting of chinchillas still continues," and the highly endangered Short-tailed Chinchilla, whose fur is more valuable than that of the other species, was avidly pursued (Thornback and Jenkins 1982). This species has not been bred in captivity, and domestic animals represent hybrids between the two species. The *2000 IUCN Red List of Threatened Species* lists the Long-tailed Chinchilla as Vulnerable, and the Short-tailed Chinchilla as Critically Endangered.

Koalas

The loveable Koala (*Phascolarctos cinereus*) of Australia, which never recovered from killing by the fur trade in

the 19th and early 20th centuries that nearly caused its extinction, is now in decline again. Symbol of Australia's national airline, Qantas, and one of the most famous and popular animals in the world, it is threatened by a variety of factors, including logging, urban development, and disease. Prior to European colonization of Australia, Koalas numbered in the millions in eucalyptus forests from Queensland in the north to Victoria in the south (Phillips 1994). Koalas date back at least 14 million years, having evolved in rainforests that once covered large portions of Australia. Although climatic change turned much of Australia into desert, their range in 1800 still covered millions of square miles in a continuous forest zone (Phillips 1994). These slow-moving marsupials became quite specialized in their diets, feeding mainly on about 32 of the 500 species of eucalyptus trees native to Australia; but within this habitat, they thrived (Dayton 1991).

Beginning in the 19th century, Koalas were hunted mercilessly by European settlers for their soft fur pelts and were entirely helpless in the face of guns and dogs. The major means used by professional hunters were poisoning and snaring, and by the late 19th century, 300,000 Koala pelts a year were being shipped to the London fur market (Phillips 1994). By the early 20th century, they were almost eliminated in the southern half of the country and became extinct in South Australia in the early 1930s. In 1898, legislation was passed in Victoria to attempt to stem the killing, but it was not enforced (Phillips 1994). In 1908, 57,933 Koala pelts were exported, and hunting spread to Queensland; beginning in 1915, year-round hunting was allowed (Phillips 1994). The U.S. fur trade sold millions of Koala pelts during the 1920s; from 1919 to 1921, 208,677 Koala pelts were sold in the U.S. fur trade, along with more than 7 million Australian opossum and wallaby pelts, according to a study by two American Museum of Natural History biologists, Henry Fairfield Osborn and Harold Anthony (1922). After signs of depletion and public outcry, the Queensland government closed the hunting season in 1921, but commercial pressure resulted in a re-opening of hunting five years later. In a one-month season in 1927, 584,738 Koalas were killed and their pelts sent to the United States (Phillips 1994). This was the last year of hunting. The U.S. market was finally shut down at this time when President Herbert Hoover, who had worked in the gold fields of Western Australia, signed an order permanently prohibiting the importation of both Koala and Wombat skins, an order that remains in effect today (Phillips 1994).

Populations of these animals had been devastated, however. Extinct in South Australia, they numbered only about 200 in New South Wales by 1940 and a few thousand in Victoria. In Queensland, perhaps 10,000 or more Koalas survived, but they declined when millions of acres were cleared for construction and road-building (Phillips 1994). Fragmentation of their habitat throughout their range has played a role in preventing them from returning to former abundance (Phillips 1994).

Even in the 1990s, a time when public sympathy for Koalas had grown considerably along with an awareness of their habitat needs, the government of New South Wales granted a massive woodchip contract to a multinational company, Boral, which may level every native forest left in the northeast of this state. This is the only area in New South Wales where Koalas are reasonably common (Arnold 1992). Citizen lawsuits to halt logging and other development have no legal standing in Victoria and Queensland, and in New South Wales, the government uses taxpayer money to destroy habitat and fight lawsuits (Arnold 1992). An activist organization fighting to save the Koalas, Australians for Animals, states that a mid-1990s drought on the heels of devastating forest fires in 1993 eliminated the species from much of its remaining habitat (Arnold 1992). The Koala requires a large, undisturbed eucalyptus forest. Like many animals devastated by slaughter by the fur trade and failing to recover, it reproduces very slowly. Koalas do not mature until age 5, have only one young per year (although twins have been reported) and can live to be 18 years old in the wild (Nowak 1999).

Beginning in 1985, Koalas faced yet another devastating threat. The first diseased animals suffering from an epidemic of chlamydia were found, many of them blind, sterile or dead (Dayton 1991). Dr. John Woolcock, a veterinary microbiologist at the University of Queensland, has studied the organism attacking Koalas, a pathogen known primarily as an avian disease; the disease affects the eyes and the urinary and reproductive tracts of its victims (Dayton 1991). "It brings tears to the eyes to see blind animals or those with weeping inflamed eyes," said Woolcock (Dayton 1991). The Koala Preservation Society of New South Wales, first organized in 1972 by Jean and Max Starr, began caring for injured and diseased Koalas and constructed a Koala Hospital in the Macquarie Nature Reserve to

rescue the growing number of diseased animals that were brought to them (Phillips 1994). Enclosures were built with eucalyptus trees for their first patients; by 1990, more than 2,000 Koalas had been treated (Phillips 1994). A second hospital had to be built in 1986 near a regional headquarters for the National Parks and Wildlife Service; blind Koalas are kept in large enclosures and hand fed by volunteers (Phillips 1994). *Koalas. Australia's Ancient Ones*, a book by Ken Phillips (1994), describes the extraordinary care given by the organization to these sick and injured animals, who are remarkably stoic and patient throughout their recuperations.

According to some Koala experts, chlamydia is endemic to Koalas, yet few healthy animals succumb to the infection (Phillips 1994). Many biologists and veterinarians believe that the increase in the spread and the number of animals succumbing to the disease is a result of the species' vulnerability from combined stresses. The loss of 80 percent of their habitat in the last 200 years has resulted in their overcrowding in fragmented bits of forest. They are stressed by the threat of dogs that hunt and kill them when they walk on the ground between trees, and many are injured or killed by cars when they try to cross roads. Stranded Koalas have been found clinging to huge electric poles with high-tension wires on all sides; they had climbed up the poles in desperation, as the only tree-like structures in a denuded landscape (Dayton 1991). Removal of just one or two species of eucalyptus from a forest may force Koalas to travel far afield to find edible species, and if they eat leaves not compatible with their digestion, they will die of starvation (Phillips 1994). Very few preserves have been set aside for them, and they are a symbol of the many endangered Australian marsupials threatened by habitat loss.

After the 1993 forest fires, many of which were intentionally set by arsonists, hundreds--and perhaps thousands--of Koalas died or were seriously burned. One critically injured Koala was dubbed Terry Glen, for the two men from the electric company who rescued him with a cherry picker, so blackened by fire that they thought at first he was a bubble of burned sap in the top of the charred tree (Phillips 1994). Terry Glen had lost most of his fur, his ears and eyelids were singed, his nails burned off and he was in deep shock. In the Koala Hospital's intensive care unit, veterinarians treated him as if he were a human burn victim, with special bandages and rehydration. For months he had to be carried around because he could not walk on his bandaged feet; remarkably, he survived. After more than a year in treatment at the hospital, with volunteers providing eucalyptus leaves and special attention to encourage eating and exercise, Terry Glenn, looking like a normal, healthy Koala, was released back to the wild (Phillips 1994). Many burned Koalas were rescued by private citizens during the 1993 fires and treated in their homes, with guidance from the Koala Hospital and other veterinarians. Some were lucky enough to recover to be released to the wild. Although Terry Glen apparently survived after release, several Koalas, after lengthy care, were released only to be killed by dogs. The majority of Koalas, however, do not survive forest fires, another factor contributing to their decline.

The combined effects of land clearing, fire, hunting, disease, automobile collisions, predation, and continued failure by Australian states to protect Koala habitats may end in their extinction. The Koala's gene pool has been depleted, and its extreme vulnerability to disease in the late 20th century may be a symptom of a weakened species declining to extinction. The U.S. Endangered Species Act lists the species as Threatened, but it is not protected by CITES.

Spotted Cats

In the early 1960s, a disastrous fashion trend in spotted cat furs was launched when First Lady Jacqueline Kennedy appeared in a Leopard (*Panthera pardis*) coat sold to her by Ben Kahn Furriers in New York (*The New Yorker* 1967). An instant craze for spotted fur coats developed, and in 1968, 9,556 Leopard skins, 1,283 Cheetah (*Acinonyx jubatus*) skins, 13,516 Jaguar (*Panthera onca*) skins, and 133,064 skins of the small Ocelot (*Leopardus pardalis*) were imported into the United States (Stewart 1977). Profits were at first considerable, as skins were plentiful and reasonably priced to the importers. Soon, however, the spotted cats became rare in the wild, and prices for pelts rose. One employee of a fur manufacturer, who specialized in cutting the pelts of spotted cats into coats, told a reporter

from *The New Yorker* (1967) that as many as eight Somali Leopards were needed to make a coat, and at least 25 of the smaller cats. In 1966, he paid $250,000 for spotted cat skins which he made into 900 coats. "They must be killing these animals off very fast," he said. "I handle the skins of animals that were in the jungle three days before. They are flown here with the blood still on the fur" (*The New Yorker* 1967). Tiger skins were also used, though only for extremely expensive coats. In the early 1960s, the actress Gina Lollabrigida appeared in a Tiger coat that had cost the lives of at least six of these endangered cats. When questioned about the morality of wearing such a coat, she exclaimed that they were already dead when she bought the coat.

By 1969, the fur industry had pushed many species of these beautiful and regal animals to the verge of extinction. The animals declined because they were rare in the wild, had large territories, were trophy hunted, were persecuted by livestock farmers, or pushed from their territories as a result of habitat destruction. Protests and publicity began to mount to ban sale of their fur. In 1969, the U.S. Congress enacted the Endangered Species Conservation Act, which included prohibitions on the importation for commercial purposes of many foreign species. Several subspecies of critically endangered Leopard and Tiger populations were added to the list, but entire species did not receive protection. Exploitation was scarcely affected because once they are made into coats, subspecies cannot be distinguished from each other. Even when skins are imported, Customs officials and even Fish and Wildlife Service Inspectors are usually not able to distinguish one subspecies from another. The trade in spotted cats continued until passage of state laws, beginning with the Mason Act in New York in 1970, which banned the sale of fur from the Leopard, Cheetah, Snow Leopard (*Panthera uncia*), Clouded Leopard (*Neofelis nebulosa*), Tiger, Jaguar, and two small spotted cats, Margay (*Felis wiedii*) and Ocelot. Six other states followed suit. The U.S. Endangered Species Act of 1973 finally cut off imports by adding the full species of most large and many small spotted cats.

World trade in spotted cat pelts remained a major threat to them, as Paris, London, Rome, Tokyo and other cities provided markets for garments made from endangered wild cats. In 1975 when CITES came into force, several species of large spotted cats received protection on Appendix I, banning legal commercial trade. CITES listings, and the worldwide publicity concerning the plight of spotted cats, stopped most legal trade, although the majority of countries had not yet ratified the treaty. Many countries in Europe and elsewhere enacted domestic legislation to cut off their markets. Education and public opinion condemning the wearing of these coats discouraged this trade in North America and most of Europe.

In 1977, the remaining wild cat species of the Felidae family were listed on CITES Appendix II, covering all species not already listed on Appendix I. Had this designation been properly enforced, requiring all export countries to allow trade only if it does not result in a decline in wild populations, many other wild cat species would not have become endangered. Unfortunately, the fur trade merely switched from Appendix I species to Appendix II species, the majority of which were small cats. Exports from Latin America of four species of small cats--Ocelot, Geoffroy's Cat (*Felis geoffroy*), Tiger Cat or Oncilla (*Felis tigrina*), and Margay--increased in spite of national bans. Brazil banned wildlife exports in 1967 and Paraguay in 1975, but the latter country did not enforce its ban. It continued to export skins of cats killed in Brazil as well as its own country, with the majority going to Europe and Japan in the early 1980s. More than 123,000 Ocelot skins were exported from Paraguay from 1980 to 1985 (Fitzgerald 1989). In 1980, Europe imported at least 430,000 small cat skins from Latin America and Asia. This decreased to 250,000 in 1984 (Fitzgerald 1989). West Germany was the world's largest importer for more than a decade, importing between 220,000 and 370,000 skins a year until 1984, when imports dropped to 90,000 skins (Fitzgerald 1989).

The Margay is a smaller version of the Ocelot, and the Tiger Cat is a tiny spotted cat weighing only 3 to 6 pounds, native to tropical forests from Costa Rica south to Argentina (Sleeper 1995). At least 50 pelts from the Tiger Cat are needed for a fur coat. After these two species experienced steep declines in their wild populations, they were listed on CITES Appendix I along with the Geoffroy's Cat, a spotted cat the size of a domestic house cat, after it, too, became threatened from the fur trade. The U.S. Endangered Species Act lists all three species as Endangered.

The exploitation of these small cats was carried out, for the most part, in countries totally protecting these species,

and is a shocking example of greed, lack of enforcement of laws in their countries of origin, and total disregard for conservation on the part of importing countries. Many of these cats remain endangered from illegal hunting and habitat destruction. The Ocelot, for example, has a low reproductive rate and requires dense forest cover and abundant small prey, making it vulnerable to declines resulting from the rampant deforestation occurring in much of its range. Moreover, in many parts of South America, spotted fur coats are still openly sold or exported to countries that lack strict legislation relating to the sale of endangered species. Population surveys have not been carried out for the majority of these wild cats, and their numbers are estimated based on available habitat, a less than precise method. The Ocelot and many other small spotted cats remain in the Endangered category on the U.S. Endangered Species Act and on CITES Appendix I.

The Asian Leopard Cat (*Prionailurus bengalensis*) became exploited when Latin American small cats declined until it, too, became endangered in India, Bangladesh and Thailand. These populations are now on Appendix I, but cannot be distinguished from other populations when in coat form, making the listing meaningless. In 1993, CITES committees made a recommendation to all member countries that they suspend imports of Leopard Cat pelts from China until that country implemented recommendations for the conservation of this species. One after another of the small cats have become threatened and listed on CITES Appendix I or the U.S. Endangered Species Act.

Exports of North American Bobcats (*Felis rufus*) and Lynx (*Lynx canadensis* or *Felis lynx*) rose during the 1980s for this voracious market. This has caused declines in many populations of both species, especially the Lynx, a northern wild cat with low population density. It is dependent on the cycles of the Arctic Hare, its main prey. At the height of the wild fur boom of the 1980s, trappers pursued Lynx into Alaskan national parks. In one case, a trapped Canadian Lynx was brought food for six weeks by other Lynx. South of Canada, Lynx are extremely rare and are listed by the U.S. Endangered Species Act as Threatened as of March 24, 2000. Eurasian Lynx (*Felix lynx*) are also being killed for the fur trade. In western Europe, this species verges on extinction from centuries of persecution and habitat destruction, but in eastern Europe and Central Asia exploitation continues. CITES committees recommended in 1993 that member countries suspend imports of Lynx from Azerbaijan, Latvia, Lithuania, Moldova and Ukraine until these countries implement the recommendations of the Animals Committee relating to the need for population surveys because of the listing of this species of Appendix II. These recommendations are not, however, legally binding.

Open sale of even the most endangered spotted cats continues in some countries. At various times in the 1990s, highly endangered spotted cat garments have been openly sold in Japan, Taiwan, Hong Kong, Greece and West Germany, as well as in some of the countries of origin, such as Argentina, Kenya, Nepal, Vietnam, Laos, India, South Africa and Indonesia. Tiger skins are still being sold illegally for as much as $20,000 each. At a time when each Tiger's life is of utmost importance in conserving the species, illegal hunting is killing off the remaining Tigers at a far greater rate than they can sustain. In the first months of 1994, two Tiger skins were confiscated in India; one of the skins was from a Tiger that had been recently killed with poison near Kanha National Park (TRAFFIC 1994). In Ho Chi Minh City, Vietnam, Tiger skins and heads are sold in souvenir shops, with no apparent control of this trade by authorities. Leopard skins are also being smuggled by an international criminal network from India to the Persian Gulf (TRAFFIC 1994). Logging companies in Myanmar, formerly known as Burma, capture and kill wildlife on a large scale, offering Leopard and Marbled Cat (*Felis marmorata*) skins for sale (Hill 1994). The world's fastest land animals, Cheetah, number only between 9,000 and 12,000 in Subsaharan Africa, yet many are still killed and their pelts smuggled to parts of Europe and Asia. Farmers and ranchers in Namibia and other countries of southern Africa kill Cheetah as predator control, and then sell their pelts.

In Katmandu, Nepal, surveys in the late 1980s and 1990s by conservation organizations uncovered a major illegal trade in protected animals. In a 1988 survey, researcher L.J. Barnes posed as an American tourist and found 50 shops selling furs. In these stores, he counted 60 Leopard Cat coats, 19 Leopard coats, four Clouded and four Snow Leopard coats on open display (Heinen and Leisure 1993). In 1988 to 1989, a full-length Snow Leopard coat was openly offered for sale in a store along with two Clouded Leopard coats; in February 1992 and early 1993, Clouded Leopard coats were still being offered (Menon 1994). Coats made of the pelts from small cats, such as the Fishing Cat, Jungle

Cat and Desert Cat, were commonly offered for sale in 1991. The number of stores selling furs in Katmandu increased by 44 percent between 1988 and 1991, and the sale of endangered spotted cat coats had not declined. A few years later, a third survey of fur stores found that sales of these items actually increased: 29 Leopard coats made from an estimated 203 Leopards, and two Appendix I Snow Leopard coats made from at least 14 of these endangered animals were seen (Menon 1994). The 1993 survey found 76 shops selling 1,225 fur items from a variety of endangered species. An official from the CITES Secretariat traveled to Nepal in 1993 to meet with senior officials from the wildlife department to inform them of the surveys and their findings; the Nepalese officials agreed to take action to investigate irregularities (Menon 1994). A follow-up visit to Katmandu later in 1993 found no change; 35 shops were visited, and all continued to sell protected species openly (Menon 1994). A 1993 Nepalese law prohibits the killing, sale or trade in Snow or Clouded Leopards, with fines of $1,200 to $2,250 for offenses and a prison term of one to 10 years for killing or wounding; for illegal trade, fines of $1,500 to $3,000 and a prison term of five to 10 years, according to TRAFFIC International. Both the Clouded and Snow Leopards are listed on Appendix I of CITES, to which Nepal is a Party.

In neighboring India, the sale of certain furs was banned in 1979, but fur traders in Delhi received permission to continue to display their fur items for sale until stocks were depleted. This led to an indefinite reprieve in 1987 by the Delhi government, according to TRAFFIC India. The latter organization petitioned the government in 1993 to stop this trade, and the ban was reinstated, but delays in implementation resulted in the continued sale of many banned furs. A second petition to the Delhi High Court by TRAFFIC India and WWF India resulted in a court order calling for traders to stop sale by January 1994, pending a final decision. This applies only to Delhi, however, and endangered cat furs continue to be sold elsewhere in India. In 1996 alone, the skins of 14 Tigers and 64 Leopards were seized in various parts of the country, some as they were being exported, according to the Wildlife Protection Society of India.

The break-up of the Soviet Union has resulted in a wildlife slaughter by fur hunters in Central Asia. The poverty of rural people in Kazakhstan and other republics resulted in an appreciated value of furs; the skin of a Snow Leopard is worth 60 times the minimum yearly wage, or $500 to $2,000 (Koshkarev 1994). The scale of poaching is enormous; 12 Snow Leopard skins and 34 Turkestan Lynx (*Lynx lynx isabellinus*) were offered for sale in 1994 in a single village, and another 10 were trapped in the winter of 1993 to 1994 by a shepherd in the Bzhety-Oguzskiy region (Koshkarev 1994). In much of Central Asia and the Tibetan Plateau, Lynx and Snow Leopards are killed because they are considered a threat to sheep and also for their pelts (Schaller 1998). Hundreds of Snow Leopard skins from Tibet have entered the international fur trade, and so many of this species have been killed in Bhutan and India that the species is nearly extinct there (Schaller 1998). Even in the immense Chang Tang Reserve of Tibet, an area with extensive habitat for Snow Leopards, they are rare even though their major prey, Blue Sheep, were present (Schaller 1998).

Many people in Central Asia have turned to hunting furbearers at an unprecedented level, killing an estimated half of the Snow Leopard population in one region in a single winter (Koshkarev 1994). The major prey of the Snow Leopards in the area, Grey Marmots (*Marmot baibacina*), are also being eliminated by fur hunters, with 600 to 800 caught in a season (Koshkarev 1994). The Snow Leopard pelts are being sold through the black market to foreign tourists and Russian cities (Koshkarev 1994). These elusive and shy cats are among the most beautiful in the world, and their skins are one of the most coveted of all furs. They have been hunted, trapped and pursued throughout their high-altitude range in India, Pakistan, Afghanistan, China, Nepal, Mongolia, Bhutan and the former U.S.S.R. from the Altai Mountains to the Hindu Kush to the Himalayas (Sleeper 1995). Snow Leopards are rare throughout their distribution, ranging up to 18,400 feet, dependent on prey such as Blue Sheep, Ibex, Musk Deer, Tahr, Wild Boar and Marmot, which are themselves rare in this mountainous terrain, and are subject to heavy trophy and meat hunting. Fewer than 10,000 Snow Leopards may remain in the wild (Schaller 1998).

Vietnam and Laos also sell coats and skins of large spotted cats, and China has provided a new market for many of these products. In 1997, a survey in Yunnan Province on the border with Vietnam found skins of Asiatic Golden Cat (*Catopuma temminckii*), Marbled Cat (*Pardofelis marmorata*), Leopard Cat and Fishing Cat (*Felix viverrina*) being

sold in cities in the region (Li and Wang 1999). Officials in the region consider this trade, which includes many endangered species, to be of minor importance in spite of regulations and laws prohibiting it (Li and Wang 1999). Also in Yunnan Province, Customs officials uncovered a scheme to smuggle large numbers of animals by mail. Tracing information relating to packages of animal skins, officials arrived at a house where 11 Tiger skins and many Leopard skins were kept (*TRAFFIC Bulletin* 1999). Another raid in Fuzhou, Fujian Province, China, netted a large number of animal skins and parts in a truck; among the items were Tiger and Leopard skins. In a seven-month period between 1998 and 1999, 11 Tiger skins were seized, many near Kanha Tiger Reserve, along with Tiger skeletons and bones for the Traditional Medicine trade (*TRAFFIC Bulletin* 1999).

A survey of markets in Cambodia in 1994 revealed the pelts of Tigers and Leopards openly displayed in villages on the border with Thailand; Thai buyers cross the border to purchase these pelts (Martin and Phipps 1996). The investigators were told that live Tigers, usually young animals, are sold for $200 to $250 to traders in Phnom Penh, who then ship them alive to Vietnam, especially Ho Chi Minh City, where they can be sold for as much as $5,000 (Martin and Phipps 1996). Leopard skins were seen in both 1994 and 1995 in Phnom Penh and Ban Long, offered for $50 each (Martin and Phipps 1996). Cambodia is a member of CITES, and prohibits hunting and export of wildlife, but does not have strong legislation regulating sale of animals (Martin and Phipps 1996).

Leopards are still being killed for their fur in African rainforests as well. In 1999 and 2000, Michael Fay, a wildlife biologist with the Wildlife Conservation Society, walked 1,500 miles across Congo and Gabon to draw attention to the urgent need to protect this wilderness from loggers and bushmeat hunters. The National Geographic Society filmed the walk (fiExtreme Africafl and fiNdoki Adventure,fl shown in March 2001 on National Geographic Explorer), documenting the discovery of a large poaching camp with hundreds of dead animals, including the skin of an extremely large Leopard. Fay and the others set fire to the skin and burned the campsite down. The last rainforests of Central and West Africa are being stripped of their wildlife by bushmeat and animal skin hunters at a completely unsustainable level.

Clouded Leopards were not heavily exploited until the 1980s, but Appendix I listing has not prevented continued exploitation of these endangered Asian cats. Coats from these beautiful cats can sell for as much as $80,000. The tale of one Clouded Leopard's death was recounted in the newsletter of the World Endangered Species Protection Association of Taiwan:

> *. . . in the jungles of South Pahang in Malaysia ..some aborigines came to my camp and told me they had caught a tiger. A few hours later I saw her. She lay in a bamboo cage with a shattered front paw; a mess of rotting tissue and splintered bone. I was filled with misgivings and should have put her out of her misery at once, but I loved her on sight and couldn't bring myself to do it. She was not a tiger, but that most handsome of felines, a clouded leopard. Her captors . . . gathered around, indifferent to her suffering. She was caught in a 'Jerat' or steel trap which tightens when the animal struggles. No trace of suffering showed as she faced me with eyes blazing with menace . . . Despite her terrible wounds and the cramped conditions of her cage, she looked magnificent . . . I got it back to my camp and amputated its wounded paw . . . [later]. I found her tearing at the bandages on the stump of her paw with her teeth . . . Two days later it was eating out of my hand, although growling menacingly as it did so. It seemed to be well on the road to complete recovery then, suddenly its wound became infected and it died. Few events have saddened me more.*
>
> Charles Shuttleworth, from *Adventures of a Sapient Primate* reprinted in *WESPA NEWS* November 1994, Taipei, Taiwan

It is rare that one hears of the suffering wild animals endure in order to be turned into frivolous clothing. The pelt of the Clouded Leopard is a mosaic of large black, yellow and white rosettes, somewhat like the markings of a Giraffe, yet its beauty may spell its extinction.

Wild cats, especially large species like Tigers and Leopards, like many other endangered species, require a great deal of territory and are thinly distributed over their range. They live at least 10 years in the wild and have very few young each year, far fewer than domestic cats. Kittens stay with their mothers for up to two years, learning how to hunt and survive. Hunters killing a wild mother cat with kittens, even when they are 6 to 8 months old, kill two generations. All cat mothers are fiercely devoted to their kittens, willing to confront all types of dangers, including hunters and trappers, to protect them. These characteristics are shared with other families of animals that can quickly become endangered by killing and are slow to recover their numbers.

The trade in large and small spotted cats continues to decimate their wild populations because buyers for their pelts can be found throughout the world, whether sold openly, as in some countries, or as hidden merchandise. Official indifference, either from failure to enforce strict laws against hunting or sale, non-membership in CITES, or the failure to enact strict domestic legislation, can contribute to this trade. The present lack of enforcement powers or even sanctions by CITES has dire consequences for endangered species in view of the enormous market for their products. The *2000 IUCN Red List of Threatened Species* lists some, but not all, subspecies of the Tiger as Critically Endangered, and the species as a whole as Endangered. The actual status of this magnificent animal throughout its range appears to be Critically Endangered as a result of the fur trade; the Traditional Medicine trade, which uses its body parts for various purposes; along with persecution and habitat loss. At the present rate of loss of one Tiger per day out of a population totaling only about 5,000 animals, many conservationists and scientists have predicted its extinction in the wild within a decade or less. The IUCN also fails to list the full species of Leopard or Ocelot in any category, while including some of their subspecies. In the view of many, legislation and International Treaties have solved the problem of killing of these animals, but surveys of markets and seizures of poached animals indicate otherwise.

Otters

Among the most playful and intelligent of all animals, otters have been unfortunate in having durable, waterproof fur that is highly desired for coats, jackets and other fur items. Otters of 13 species are found on all continents except Antarctica and Australia, but throughout their ranges, they are thinly distributed and vulnerable to overtrapping.

Many species have incurred great losses from the fur trade. All species of otters (family Lutrinae) are now listed on CITES, with five species and one subspecies on Appendix I, and the remaining on Appendix II. Four species and two subspecies are listed on the U.S. Endangered Species Act. Seven species were listed in the *1996 IUCN Red List of Threatened Animals* (one as Endangered, four as Vulnerable and two as Near-threatened) (Baillie and Groombridge 1996). The downward trend of otters was reflected in the fact that the *2000 IUCN Red List of Threatened Species* listed 11 species (four as Endangered, three as Vulnerable, one as Near-Threatened, and three as Data Deficient). This represents 85 percent of all otters. The large number of species that are threatened is an indication of the massive declines that otters have suffered over the past century, in large part due to the fur industry.

The Sea Otter (*Enhydra lutris*) is a large marine species, heaviest of all otters, weighing up to 45 kilograms (Reeves *et al*. 1992). Living in groups called rafts that float just offshore, they were nearly exterminated throughout their range by the fur trade. Killed for their extremely valuable pelt, pursuit of these otters during the 18th and 19th centuries was among the most destructive and thorough of any in the history of the fur trade. Originally numbering from 250,000 to 300,000, Sea Otters once occurred throughout the North Pacific rim, from Baja California, Mexico,

north along the coasts of North America to Alaska, the Aleutian Islands, Russia and the northern Japanese archipelago (Reeves *et al*. 1992). The German-born Arctic explorer George Steller encountered thousands of Sea Otters during his stay on Bering Island in 1741; his party killed and ate 700 animals, describing adults as fifairly good to eat,fl and the young as fidainty as suckling lambfl (Peck 1990). Steller's navigator, Vitus Bering, considered the soft, thick pelts a resource which could provide great potential wealth, bringing 900 pelts to Russia (Allen 1942). When Catherine the Great, Empress of Russia, saw one of the skins, she ordered a cloak of Sea Otter to cover her from throat to ankles, launching an onslaught of hunting. Many pelts were traded to the Chinese, who valued them highly (Allen 1942). By the late 19th century, its pelt sold for up to $165, and as it became rarer, the price rose to $1,125 by 1903 (Nowak 1999).

At first, Sea Otters were easy to kill, having no fear of humans (Peck 1990). One Russian traveler wrote, "They covered the shore in droves; they would come up to our fires and would not be driven away." Sea Otters approached the Russians on Bering Island and rubbed their noses against the legs of sailors, who immediately bludgeoned them to death (Nickerson 1984). "When it receives a vigorous blow upon the head," one hunter observed, "the otter falls upon the ground, covers its eyes with its paws, and keeps them so, no matter how many times it is struck." The native Aleuts considered them to embody spirits of their own dead, and at first refused to hunt them at all (Peck 1990). Russian seamen forced the Aleuts to produce otter pelts by threatening to rob and pillage their villages and take their women hostage for the furs (Peck 1990). If Aleut hunters failed to produce the furs, the hostages were raped and murdered (Peck 1990).

The Sea Otters were shot as they lay in kelp beds, clubbed when they surfaced from dives to breathe, and netted in wide coarse nets (Allen 1942). On land, they were pursued as they sought shelter among rocky shores, and then clubbed to death. Perhaps the cruelest method was the capture of a pup when the mother dove for food. A cord was tied to the foot of the pup, with fish hooks placed close to its body and attached by the cord. Retiring to the shore, the hunter would pull the cord, hurting the pup so it would cry, bringing the mother, who would become caught in the line or hooks or, so occupied in freeing her offspring, easy prey (Nickerson 1984). The killing of 15,000 Sea Otters by the Russian and English near Bering Island caused the otters™ extinction on the island, and they remain absent there today. After less than a century of intense hunting, only 15 otters were found and killed in the entire Aleutian chain in 1826. During the next decade, however, new herds were discovered in Alaskan waters, and in the mid-19th century, about 5,000 Sea Otters were taken per year. Over the 30 years that they were hunted in southern California, an estimated 50,000 were taken, with at least 5,000 a year killed in San Francisco Bay (Nickerson 1984). By 1833, only 54 Sea Otters were found in the Farallon Islands off California; they were soon killed off. This hunting was carried out by enslaved Aleuts brought from Alaska (Nickerson 1984).

By 1900, the Alaska Commercial Company, operating five trading posts and 16 schooners, was able to find only 31 Sea Otters, whose pelts were sold at $1,000 each (Allen 1942). In 1910, Sea Otters finally received protection under the North Pacific Fur Seal Act, but they had reached the verge of extinction, numbering, in the opinion of biologist Karl Kenyon, only between 1,000 and 2,000 animals (Nickerson 1984). They had been hunted out of much of their territory, including the long coastline from southeastern Alaska to northern California, where a tiny remnant population survived. An estimated 500,000 Sea Otters had been killed between 1740 and 1911 (Reeves *et al*. 1992). The scattered remnants of this species continued to be killed wherever they were found. When small numbers of Sea Otters were spotted between the 1890s and 1917 in the waters off San Luis Obispo and Monterey, California and near islands off Baja California, Mexico, they were immediately shot (Nickerson 1984). Although the Russians predominated in the hunts, Americans, alerted by Captain James Cook in the 18th century, were almost as responsible for the near-extinction of these beautiful animals.

In the 1950s, after an apparent recovery of the species in Alaska, the state Department of Game began a program of experimental harvesting; from 1962 to 1971, 2,933 pelts were taken for zoological data and for possible sale in the fur market (Reeves *et al*. 1992). Their world population numbered about 32,000 by 1965 (Nickerson 1984), and hunts were ended in U.S. waters by passage of the Marine Mammal Protection Act of 1972. Take by native Alaskans is permitted under certain conditions, and some native hunters have killed large numbers of Sea Otters (Reeves *et al*.

1992). Populations totaled an estimated 100,000 to 150,000 in the early 1990s, with the largest numbers off Alaskan coasts (Nowak 1999). The Sea Otter has not reoccupied many parts of its original range, including former strongholds such as the Pribilof Islands, Bering Island, the Queen Charlotte Islands off British Columbia, Oregon, Mexico and most of California (Reeves *et al*. 1992); and reintroduced populations have not fared well (Nowak 1999). The species numbers about 17,000 off Russian coasts (Nowak 1999).

The *Exxon Valdez* oil spill in 1989 killed up to 10,000 otters in this center of their population in Prince William Sound, Alaska (See Aquatic Ecosystems chapter for more about this spill). Yet another unexpected threat is killing large numbers of Sea Otters off Alaska. In an ecological catastrophe caused indirectly by human activity, Sea Otters are now being preyed upon by Killer Whales (*Orcinus orca*). The latter animal has been deprived of its traditional prey in Alaska, Steller Sea Lions (*Eumetopias jubatus*), which have become endangered as a result of overfishing of their prime food supply--herring, pollock and ocean perch--by commercial fishing boats (Stevens 1999). Scientists began noticing the decline of Sea Otters in the early 1990s in the Aleutian Islands and western Alaska, a coastline stretching for 2,000 miles. Populations in some areas had declined by 50 percent, and by 1997, a survey found losses up to 90 percent (Stevens 1999). In one 500-mile stretch, Sea Otters had dropped from 53,000 in the 1970s to only 6,000 (Stevens 1999). The entire ecosystem has also been affected by the decline of Sea Otters. They are a keystone species, keeping kelp forests healthy by eating large numbers of sea urchins, which feed on kelp. Now large stretches of coast have lost their kelp beds, causing the entire ecosystem, from mussels to Bald Eagles, to decline (Stevens 1999). Other threats to Sea Otters include persecution by fishermen, shooting, oil and toxic chemical pollution, loss of food supply from overfishing, and ship traffic. The small population in Southern California has also been declining. In 1996, the Sea Otter was not listed in the *IUCN Red List*, but its sudden loss in numbers in Alaska and elsewhere in its range has again placed the species in danger of becoming extinct. The *2000 IUCN Red List of Threatened Species* lists the Sea Otter as Endangered.

During the 1960s, otter fur became popular in the fur industry, causing an enormous decline in wild otters as trappers combed tropical rivers and wetlands for these vulnerable animals. The United States imported 45,000 otter skins per year from South America between 1965 and 1969, primarily from Brazil and Colombia, according to U.S. Department of Commerce statistics. All four of the Neotropical otters occurring from Mexico south to the southern tip of South America are now on Appendix I and have declined to threatened or endangered status from trapping.

The Giant Otter (*Pteronura brasiliensis*) is the largest of all otters, reaching almost 8 feet in length from its nose to the tip of its tail (Nowak 1999). Once common in river systems in Colombia, Venezuela, Guyana, French Guiana, eastern Ecuador, Peru, Brazil, Paraguay, Uruguay and northeastern Argentina, it has disappeared from most of its range and become extremely rare where it survives as a result of killing for the fur trade (Nowak 1999). These otters have been relatively easy to hunt because they live in large, friendly groups in feeder creeks and quiet, slow-moving rivers, denning in river banks. They vocalize to one another as they swim and gather on land, often in very loud chirps and barks. Thousands were killed, even after the species was protected by CITES Appendix I and hunting was banned throughout its range. When one otter is trapped or shot, others quickly come to its aid, becoming vulnerable to shooting; this seals the fate of entire groups of these beautiful animals. This trait of altruism is shared by other species of otters and has contributed to their elimination from entire areas. Trappers often set traps next to one another to take advantage of the extremely close ties between otters; one trapped otter might then bring others, which would become trapped as well. Pelts of Giant Otters were smuggled to European furriers in the 1980s, and this illegal trade has not been completely controlled by either exporting or importing countries. The Giant Otter is classified as Endangered on the *2000 IUCN Red List of Threatened Species*.

The Southern Marine Otter (*Lutra felina*), a very rare species, is considered one of the most endangered of all otters. These very small otters, less than 4 feet long, are native to the cold coastal waters along the coasts of Peru and Chile; they have been hunted for centuries for their valuable pelts (Reeves *et al*. 1992). Darwin found them abundant in the Cape Horn and Tierra del Fuego region in 1830, but 130 years later they had been hunted to extinction in that region (Thornback and Jenkins 1982). Although now protected and listed on Appendix I of CITES, they continue to be hunted for their fur and persecuted by fishermen. In Chile, where the Marine Otter is highly valued for its pelt, *The*

IUCN Mammal Red Data Book reported that the fur of this species is the most valuable of all otter fur, with hunting carried out from boats that cruise the coast for months at a time, killing any otters seen (Thornback and Jenkins 1982). On land, hunters with dogs chased them down and they were shot on sight, with pelts selling for up to $75 in the 1970s (Thornback and Jenkins 1982). Legal protection in Peru was accorded in 1977, before which a trapping season had been designated. The extent of illegal trade in South American otters is not known. Fishermen persecute Peru them for supposed damage caused to freshwater prawns, killing many (Mason and Macdonald 1986). There may be as few as 1,000 Marine Otters left in the wild (Nowak 1999), and they are listed as Endangered by the *2000 IUCN Red List of Threatened Species*.

Trade in the late 1960s also affected the other two species native to the continent. The Southern River Otter (*Lutra provocax*) is listed as Endangered by the *2000 IUCN Red List of Threatened Species*, an upgrade from Vulnerable in the 1996 version of the list. It has a limited range in Patagonia in Argentina and southern Chile. Having been eliminated from the majority of its range by trapping for fur, the Southern River Otter is now confined to remote and inaccessible areas in Argentina, such as national parks. The species has been reduced to small, isolated populations in south-central and southern Chile, where illegal hunting continues (Mason and Macdonald 1986). The Neotropical or Long-tailed Otter (*Lutra longicauda*) occurs from northwestern Mexico south to Uruguay. Both are CITES Appendix I species and listed as Endangered on the US Endangered Species Act; the *1996 IUCN Red Data Book* omitted the Long-tailed Otter (Baillie and Groombridge 1996), while the 2000 version of the list classified it as Data Deficient. The Long-tailed Otter, in spite of its extensive distribution, is considered by some experts to be "severely depleted" in many parts of its range in South America. The majority of the 113,718 otter skins exported from Peru from 1959 to 1972 were of this species (Mason and Macdonald 1986). In the early 1970s, between 6,000 and 8,000 Long-tailed Otters were legally killed per year, with probably an equal number taken illegally (Mason and Macdonald 1986).

In 1973, Colombia banned the killing of otters, but poaching continued because otter pelts have a very high value; in Chile, for example, an otter skin is worth two or three months' wages to an unskilled worker. In spite of legal protection since 1924 in Chile, otters continue to be hunted with very little enforcement of the law (Mason and Macdonald 1986). During the 1960s and early 1970s, trade records did not differentiate between the four South American otter species. Since that period, all trade has been illegal, but in spite of CITES Appendix I listings, a large number of pelts of these species are exported to the fur markets of Germany and Italy, and others are sold locally in fur stores in Buenos Aires and other South American cities.

Otters of all species produce relatively few young, and have evolved with a low natural mortality rate. They are known to live to an average age of 15, and perhaps as long as 30 years (Nickerson 1984). Species with these traits, along with their large habitat requirements and protective behavior toward one another, are extremely vulnerable to extinction. Otters play an important role in aquatic ecosystems by taking slow and injured fish, thus preventing fish overpopulation, which results in undersized fish.

Tibetan Antelope

Few people have ever heard of an antelope known as the Chiru, or the Tibetan Antelope (*Pantholops hodgsonii*), yet it produces shahtoosh, a wool far more valuable than gold. This statuesque animal is native to treeless steppe above 5,000 meters in Chinese Tibet and adjacent northwest India. Its extremely lightweight, delicate wool has traditionally been woven into shawls and sold in a limited trade in Tibet and Kashmir, India. Within the past few decades, however, a growing market has developed in major cities in India, Nepal, several western countries and Japan (Schaller 1998).

The Chiru has been listed on Appendix I of CITES since 1979, a listing which bans commercial international trade, and CITES Parties passed a resolution (Resolution Conf. 11.8) on the fiConservation of and control of trade in

Tibetan antelopefl in 2000. It is totally protected by Indian (Kumar 1993) and Chinese law (Schaller 1996). Until recently, however, the major trading state of Kashmir in India allowed trade in shahtoosh, in defiance of a ban included in the national Indian Wildlife Protection Act (Currey 1996). In Tibet, illegal hunting, even by government officials, supplies the trade, with many thousands of Chiru killed each year--with the wool smuggled to India (Schaller 1998).

Populations in India probably do not exceed 200 animals, while in Tibet these antelope were estimated to number fewer than 75,000 animals in the mid-1990s, reduced from an estimated million animals a century ago. Great herds were seen on the steppe in the 19th century (Schaller 1998). The *1996 IUCN Red List of Threatened Animals* listed the species as Vulnerable. In the 2000 version of the list, the species was upgraded to Endangered. Illegal trade and continued killing have pushed the species closer to extinction, with an estimated 20,000 killed per year.

In spite of this antelope's remote habitat, the enormous prices paid for shahtoosh (up to $1,250 per kilogram), and low fines for infractions, have fueled this illegal trade (Kumar 1993). Dr. George Schaller, who has conducted many years of research on Himalayan wildlife, found this wool being illegally traded in a Nepalese town on the Indian border in the early 1990s (Kumar 1993). Forty shawls of shahtoosh were seen in several shops in New Delhi in 1993; half of these were in one shop, which is state-owned (Kumar 1993). Indian tradesmen have misrepresented the wool as obtained from bushes that the antelope rubbed up against; in fact, Chiru are killed to obtain the wool (Schaller 1996). In the early 1990s, shawls retailed at $2,000 to $8,500 in western markets. A single Chiru provides about 150 grams of wool, and each scarf represents at least two dead Chirus, according to Schaller (1996, 1998). In 1992, the wool of at least 13,000 Chirus was confiscated in India (Schaller 1996), and in 1993 and 1994, the wool of at least 17,000 Chirus reached Indian markets (Schaller 1998). In June 1993, Indian Customs officers at Delhi airport seized a shipment of 105 kilograms of shahtoosh arriving from Katmandu, Nepal (Kumar 1993).

Large numbers of Chiru are poached near the Chang Tang Reserve, established in 1993 to preserve Tibet's wildlife, and smugglers trade shahtoosh for Tiger skins and bones, providing conduits through which the contraband travels (Currey 1996). Schaller saw Tibetans in the early 1990s with truckloads of Chiru hides, and at least one driver was arrested with 300 hides. Families moved into the Aru Basin, a great stronghold for the species within the Chang Tang Reserve, specifically to hunt Chiru in 1991 (Schaller 1998). These previously impoverished nomads were able to purchase a truck from the profits of their sale of Chiru hides, which they offered to Schaller (1998) and his group in 1992 for the equivalent of $28 each (Schaller 1998). In 1999, government officials came upon seven herds of just-slaughtered Chiru, including many females and newborns. Several wildlife organizations are organizing anti-poaching teams, but in such an enormous territory, patrolling every herd will not be possible. The herds are in constant motion, migrating from summer to winter areas. The Tibet Forest Bureau began an effort in the early 1990s to stop the shahtoosh trade, raising the fine for killing Chiru to $118. Ten poachers were arrested in a two-month period in 1993, and checkpoints were set up in several areas (Schaller 1998). In 1995-1996, patrols in remote portions of Qinghai in western China encountered Chinese hunters armed with high-powered rifles and confiscated more than 1,600 Chiru hides (Schaller 1998). China's State Council issued a directive in 1996 that Chirus must receive better protection (Schaller 1998).

A record shipment of 400 kilograms of shahtoosh that had originated in Tibet was seized in northern India in January, 1994. Samples were sent to the U.S. Fish and Wildlife Service Forensic Laboratory, which verified them as wool from the Chiru, according to TRAFFIC International (1994). Indian courts released the 400 kilograms of seized shahtoosh in May 1996 after requests from tradesmen who claimed that the wool was perishable, according to TRAFFIC India. This decision was challenged by TRAFFIC India to India's Supreme Court which overturned the lower court's decision, keeping the wool in the possession of Customs authorities until the case was decided.

Research by the Environmental Investigation Agency (EIA) in Delhi uncovered large quantities of shahtoosh being sold in the mid-1990s, having been manufactured in factories in Kashmir (Currey 1996). A Delhi salesman offered to supply 200 to 300 shahtoosh shawls every three months, claiming that his best customers were Germans, French, Italians and Japanese, who provided a demand that exceeded supply (Currey 1996). In Bombay and Calcutta,

likewise, this wool is readily available and openly sold, marketed at $1,085 a shawl, with bulk orders of 15 shawls sold for $805 each (Currey 1996). One Calcutta dealer alone offered to supply 10 shahtoosh shawls every three months, and even instructed on methods of smuggling them abroad labeled as "handicrafts" with double invoices. Shahtoosh shawls offered at a government emporium in Bombay had official Kashmir Government labels and stamps and came with a certificate of authenticity (Currey 1996). The Bombay store offered 50 shawls per month (Currey 1996). Illegal trade has not stopped in spite of new education campaigns and a tightening of national legislation. The Indian Government appears to have little interest in enforcing its own regulations prohibiting sale of shahtoosh, although Kashmir finally banned sales in 2000 after much publicity on their role in endangering this animal. Elsewhere in the world, shahtoosh is still available. On January 22, 1997, for example, 21 shahtoosh shawls were confiscated in Hong Kong from a hotel room after a raid; the guilty party was fined $2,580 two years later, in 1999 (*TRAFFIC Bulletin* 1999).

The New York luxury department store, Bergdorf Goodman, advertised shahtoosh in 1995 as a "royal and rare" fabric, making incorrect statements about the wool having been obtained from the Mountain Ibex goat of Tibet which "sheds its down undercoat by scratching itself against low trees and bushes" from where it is gathered by local shepherds (Schaller 1998). This misinformation created the false impression that the wool was legally obtained --without hurting the animals--by hardworking, indigenous people, in order to market it as a "politically correct luxury item" (Schaller 1998). Subsequently, scarves and shawls were removed from the shelves of luxury stores in the United States, and the CITES Authorities in Italy and France took action against several major fashion houses. In February 1997, police in London seized 200 shahtoosh shawls worth an estimated $500,000 (Schaller 1998). Many famous and wealthy New York City socialites have worn these shawls, and in the late 1990s, many were interviewed during an investigation to find the stores illegally selling the shawls. By 1999, the price of a shahtoosh shawl had risen to $10,000.

This situation is very dire for the Tibetan Antelope. A major campaign is needed to stop this trade. Efforts to guard wild herds and police markets for shawls and other goods made from this wool have been underfunded. The idea of ranching Chirus for their wool has been proposed, but Schaller considers such an idea disastrous for this species (Kumar 1993). Schaller has been interviewed by CNN several times about this situation, and he has expressed his extreme concern about the trade, stating that tens of thousands of Chiru are being killed, threatening the very survival of the species.

Reptile Trade

Reptile Trade: Sea Turtles

Huge sea turtles have been laboring up the beaches of tropical shores for 50 million years, digging deep holes with their flippers and depositing their slippery eggs before making their way back to the sea. Remains of extinct species of sea turtles 12 feet long have been found. The largest living sea turtle is about two-thirds that length. Other than humans, adult sea turtles have few enemies except sharks. Even today, the great turtles are enigmas. How they find their way over thousands of miles of open sea to return to the same beach on which they hatched--often a tiny islet--is not known with certainty. In 1986, scientists discovered that the temperature at which eggs incubate determines the

sex of the hatchlings. Cool nests produced males and warm ones, females. This discovery has influenced some conservation programs which hatch eggs in captivity for release to the wild. Research is very slowly unraveling some of their secrets through tagging and radio-tracking by satellite. Within the next few decades, much more will be learned about their movements and life history. Available data indicate that females may not nest until they are at least 10 years of age or older.

All seven species of sea turtles are now endangered. They face myriad threats. Killing for leather, meat, tortoiseshell, and to be stuffed for sale as curios is one of the foremost threats. For centuries, sea turtles were exploited by native peoples, most of whom did not kill large numbers or sell them as a commodity. Only when the products entered international trade and high-volume markets were created did turtle hunting have serious consequences. "They have a unique, and for them disastrous combination of characteristics; they are . . . excellent to eat, ridiculously easy to catch, and with virtually no way of defending themselves," in the words of turtle expert, Dr. Peter Pritchard (Lehrer 1990).

Commercial exploitation of the Green Turtle (*Chelonia mydas*) began in the 1600s in British colonies in Jamaica and Bermuda. Thousands of adult turtles were killed for their meat. As early as 1620, the Bermuda Assembly passed an act to outlaw the killing of young turtles because, even by that early date, they had been decimated (Carr 1973). The British colony in Jamaica sent ships in the mid-1600s to the Cayman Islands, once considered the species' largest breeding grounds in the world, to bring back turtle meat for the colony (Lehrer 1990). By 1688, ships were transporting 13,000 Green Turtles a year to Jamaica, and this meat became a staple food for colonists. By the early 1700s, Jamaican laws protecting the dwindling turtle colonies were enacted, but were not enforced, and by the late 1700s, Green Turtles had been almost eliminated from the Cayman Islands (Lehrer 1990).

In the 20th century, nearly every part of the Green Turtle's body and shell became valuable in international markets. These turtles are found throughout the world in all tropical oceans, and exploitation was relentless. Eggs and meat were sold locally and in gourmet restaurants, and the oil was used in cosmetics; the shell was carved into jewelry, and the neck and flipper skin was tanned for leather. Even baby turtles were stuffed and sold as souvenirs. Turtle hunters discovered their most remote nesting beaches and killed the females as they laid their eggs. Whenever they were spotted on the open ocean, they were caught and slaughtered. At the beginning of the 20th century, it was not unusual to catch Green Turtles that weighed almost 1,000 pounds, but after heavy exploitation, their average size began to decrease. Today, 300-pound animals are considered large (Lehrer 1990). By the early 1970s, Green Turtles were listed as Endangered in the *IUCN Red List of Threatened Animals,* but exploitation continued to decimate them. Both families of sea turtles (Cheloniidae and Dermochelyidae) were added to Appendix I of CITES in 1977, banning commercial trade between member nations. Unfortunately, several countries, including Japan, took reservations, a formal refusal to enforce the listing, and in the 14 years before 1994 when Japan finally withdrew its reservation, it imported 130,000 Green Turtles (Thornton 1994).

The U.S. Endangered Species Act finally listed Green Turtles in 1979, seven years after they had been proposed. Breeding populations in Florida and on the Pacific coast of Mexico are listed as Endangered, while the rest of its populations around the world are in the lesser category of Threatened. Green Turtles are still being killed in large numbers in Indonesia, where an estimated 20,000 are slaughtered each year for meat, shell and eggs, according to Reuters (August 1994). The Governor of Bali set a quota of 5,000 per year for use in Hindu festivals on the island; even the latter quota will result in the extinction of these turtles in these islands within a few years. Stuffed sea turtles with polished shells are sold openly in tourist shops throughout Indonesia.

Hawksbill Turtles (*Eretmochelys imbricata*) have been slaughtered to near-extinction worldwide, mainly for their beautiful shells, which are made
into tortoiseshell jewelry and other items. Like the Green Turtle, the Hawksbill is found in all tropical oceans but is most commonly seen in coral reefs and along coastlines in mangroves and marshes. This 3-foot-long turtle received the protection of the U.S. Endangered Species Act as early as 1969, an indication of the depletions that it had undergone throughout the century. About 10 to 12 pounds of tortoiseshell are obtained from each turtle (Ernst and

Barbour 1989). Cutting off the U.S. market did not stop slaughter of these turtles, however. Tortoiseshell from Hawksbill Turtles is made into eyeglass frames that sell for up to $4,000 in Tokyo luxury stores. The shell is also fashioned into bracelets, earrings and other trinkets. The meat and eggs are consumed, and hatchlings--as well as adults--are killed and sold as stuffed curios. Listing on Appendix I of CITES in 1977 hardly slowed the trade because Japan and several other countries took reservations on the species and continued trading. International trade in Hawksbills totaled more than 250,000 animals in 1976 and 1977, and shells from 500,000 of these turtles were traded in 1978, primarily exported from Asian and Central American countries to Germany, the United Kingdom and Japan (Fitzgerald 1989). Between 1970 and 1986, Japan imported 570,000 stuffed Hawksbills, which were used to adorn the walls of houses (Fitzgerald 1989). In an average year during the 1980s, Japan imported the shells of 28,000 adult Hawksbills that had been killed in the Comoros Islands, Jamaica, Haiti, the Maldives and Cuba; the latter country was the largest supplier (Fitzgerald 1989). By 1994, when Japan withdrew its CITES reservation on Hawksbill Turtles, it had imported 400,000 of these endangered animals in the previous 14 years (Thornton 1994).

Although the Hawksbill originally nested in 60 countries in the tropics and sub-tropics (WCMC 1993), decades of heavy exploitation caused major declines and the extinction of many nesting populations. Vietnam now kills and markets thousands of these highly endangered sea turtles. They are processed at seven nesting sites along the Vietnamese coast, and tortoiseshell and stuffed turtles are sold openly in Ho Chi Minh City (formerly Saigon) and in other cities (Duc and Broad 1995). The number of Hawksbills killed in Vietnam has increased greatly in recent years. Also, eggs are collected, and local operations hatch them--another loss to wild populations. Japan announced in 1994 that it is developing a simulated tortoiseshell made of laminated silk, but it continues to provide an illegal market for Hawksbill tortoiseshell. Urgent action is needed to protect nesting turtles and stop Vietnamese exploitation to prevent extinction of Hawksbills in this region (Duc and Broad 1995). Scientists and conservationists are pessimistic about the long-term survival of the Hawksbill Turtle because of continued killing for its valuable shell. The *2000 IUCN Red List of Threatened Species* lists it as Critically Endangered.

The Olive or Pacific Ridley Turtle (*Lepidochelys olivacea*) is found only in the Pacific region, with the majority of nests located along the coasts of Mexico and Central America. They have been slaughtered mercilessly on their nesting beaches, where they gather by the thousands. The market was controlled by one man in Mexico, Antonio Suarez, a Spanish national. In 1978, one of Suarez' plants processed 50,000 Olive Ridleys, 90 percent of which were females; this was 16,000 more than the quota permitted. Mexican government quotas were far higher than the turtle populations could sustain, and catches fell precipitously in 1979 and 1980. This exploitation endangered Pacific Ridley turtles on Mexico's coasts, which brought about listing on the U.S. Endangered Species Act in 1979 of breeding populations on the Pacific coast of Mexico as Endangered and other populations as Threatened. Prior to this, skins, shells and meat from hundreds of thousands of Mexican Olive Ridleys had been imported into the United States, the major consumer of these animals.

In 1980, some 106,000 pounds of Olive Ridley meat were seized as they were being smuggled in from Mexico to various dealers in the United States; the meat came from an estimated 8,800 turtles. Turtle slaughterhouses were still operating in Mexico in 1990, and Suarez owned three processing plants. Not only was Suarez indicted for smuggling thousands of pounds of turtle meat into the United States, but his purchases of turtles from fishermen in Mexico exceeded government quotas. The species is still exploited for other markets, and the *2000 IUCN Red List of Threatened Species* lists the species as Endangered.

Rarest of all the sea turtles, the Kemp's or Atlantic Ridley (*Lepidochelys kempii*) was once widely distributed throughout the Caribbean region. By the 1940s, it had become restricted to one nesting beach in northeastern Mexico on the Gulf of Mexico. In the 1960s, a mass nesting aggregation, or "arribada," of Kemp's Ridleys, totaling an estimated 40,000 animals, was filmed. A few days of slaughter over several consecutive years reduced the enormous arribadas to only 500 nesting female turtles by 1978. This species was listed on the U.S. Endangered Species Act in 1969 as Endangered, but this did not stop the slaughter. In 1995, nests totaled 1,430, showing a gradual recovery of the species as a result of intensive protection of nesting females and their eggs by the combined work of Mexican and U.S. patrols (Hastings 1996).

Between 1978 and 1988, more than 22,000 eggs were taken from the Mexican nesting beach to Padre Island off the south Texas coast, where they were allowed to hatch and were then kept in captivity for one year prior to releasing them into the wild. For many years, this project was thought a failure, but to the surprise of all, two female Kemp's Ridley Sea Turtles that had been released from Padre Island, one in 1983 and the other in 1986, returned to nest in 1996 (Hastings 1996). The only effective way of tagging young sea turtles is a skin graft of a special light-colored spot placed on the shell, and these turtles' grafts indicated the year each was released (Hastings 1996). One female was 11 years old, and the other 14. This highly unusual project is the first known success story for sea turtle egg transplants. These turtles are also dying in large numbers in the nets of shrimp fishermen, and hundreds more die when they become disoriented while migrating in the fall, ending up in cold New England waters. The *2000 IUCN Red List of Threatened Species* classifies the Kemp's Ridley as Critically Endangered.

Loggerhead Sea Turtles (*Caretta caretta*) also drown in shrimp nets and suffer from a loss of nesting habitat. The Loggerhead is a large turtle, up to 7 feet long (213 centimeters), second in size only to the massive Leatherbacks (*Dermochelys coriacea*). Museum specimens of Loggerheads taken in past centuries weighed an estimated 1,188 pounds; today, they average only about 330 pounds (Ernst and Barbour 1989). Loggerheads have been so persecuted on their nesting grounds around the world that the original nesting range is unknown. Development of their nesting beaches and losses from drowning in shrimp nets and will probably result in the extinction of North American Atlantic populations, which nest from Florida to the Carolinas (Ernst and Barbour 1989). Within the past five years, Loggerheads of the Florida region have been found suffering from a mysterious disease which causes tumors on the head and neck, and a lethargy. Most do not survive. A sea turtle hospital in the Florida Keys has treated some of these and, in March 2001, found themselves treating more than 35 Loggerheads, only one of which responded to treatment. It is assumed that for every sick turtle found, hundreds more die at sea. The malady may be a virus caused by pollution, a toxin affecting their food supply of crustaceans and other invertebrates, or another cause as yet unknown. Although the *2000 IUCN Red List of Threatened Species* lists this species as Endangered, the U.S. Endangered Species Act classifies it as Threatened.

The Flatback Turtles (*Natator depressus*) of the Australian region may be more secure than other species but still face losses from accidental drowning and some illegal hunting. This small sea turtle, only about 39 inches in length, is found mainly in shallow, coastal waters (Ernst and Barbour 1989). They are not hunted for their meat, which is considered unpalatable, but their eggs are exploited, which could eliminate the species from many nesting beaches (Ernst and Barbour 1989). The species is listed as Vulnerable by the *2000 IUCN Red List of Threatened Species*, indicating a decline that might place it in Endangered status.

Largest of all living turtles, Leatherbacks can reach 8 feet in length and weigh up to 1,900 pounds (Ernst and Barbour 1989). They are highly endangered, as a result of overharvesting of their eggs, illegal slaughter and drowning in fishing nets. Of all sea turtles, the Leatherback is the most likely to be seen in temperate areas, even cold waters off Iceland, Labrador and Norway in the north, and Chile and the Cape of Good Hope in the south (Ernst and Barbour 1989). It also ranges through tropical oceans, occasionally entering shallow bays and estuaries. It nests on tropical beaches (Ernst and Barbour 1989). The body temperature of these turtles has been measured at 18^{o} C. above the sea water temperature, an indication that their large body size retains heat from muscular activity, and their circulatory system in fore and hind limbs allows homeothermy (Ernst and Barbour 1989). Thus, these turtles can hardly be called "cold-blooded."

Until recently, western Mexico had enormous breeding colonies of Leatherbacks, but because of killing and egg-taking, nests at Mexiquillo, a major nesting beach, they declined from 6,500 in 1984 to fewer than 500 in 1995 to 1996, according to the *Turtle Newsletter*. So many of these huge turtles have drowned in driftnets that the IUCN reclassified the species from Endangered in the 1996 list to Critically Endangered in the *2000 Red List*. In spite of having an enormous range worldwide, this species also seems destined to become extinct in the near future.

All of these sea turtles continue to be exploited, either illegally, by local peoples, or by countries not Party to

CITES. In spite of CITES and U.S. Endangered Species Act listing, the high rate of mortality from many causes is proving disastrous for these ancient reptiles. An enormous market for meat, leather and shell exists, fueled by countries that provide markets for turtle products. Hawksbills and Leatherbacks, in search of jellyfish, consume balloons and plastic bags, which prove fatal, blocking the turtles' intestines or suffocating them. Globs of floating tar and oil slicks can kill them. Many of their nesting beaches have been developed for tourism or business, discouraging nesting females, and lights at night along nesting beaches cause newly hatched baby turtles to turn away from the sea and proceed inland, instinctively crawling toward the greatest source of light. In natural conditions, this light would come from the direction of the sea and the horizon, but the misdirected hatchlings end up crushed by cars and piled up against buildings. Some seaside towns in the United States and elsewhere are prohibiting any type of beach lighting during the months when sea turtles hatch. Thousands more young sea turtles die when they swim off course during the fall and winter, ending up in frigid waters. In the winter of 1995 to 1996, hundreds of Kemp's Ridley and other species of sea turtles washed ashore on the beaches of the northeastern United States, from Long Island, New York, to Cape Cod, Massachusetts. The majority were about a year old, but some adults also died. Rescue centers were set up and saved the lives of some of these turtles.

To kill these fascinating and ancient animals to supply the tables of thoughtless diners in gourmet restaurants, or for knickknacks and eyeglass frames, is unjustifiable. At present, there is no evidence that these turtles, who breed at glacial speed and are dying from many causes that probably already exceed their rate of increase, can ever be taken in a sustained manner. Total protection from killing is needed to prevent the extinction of these venerable reptiles.

Reptile Trade: Crocodiles and Alligators

All 23 species of large crocodiles and alligators have been overexploited by hide hunting; they are now in varying degrees of threat and listed on Appendix I or II of CITES. South American caimans were so abundant in the early 1950s that millions were killed for export to Europe and the United States. Their hides are fashioned into shoes, handbags and suitcases for the luxury trade. Elsewhere, crocodiles in Africa, Asia and Australia came under similar pressure, as did the American Alligator (*Alligator missippiensis*). In fact, the depletion of wild crocodiles which began in the 1950s caused reptile hide traders to turn to turtle skin, lizards and snakes, continuing their record of massive overexploitation.

One Colombian conservationist said that prior to this massive slaughter, it was easy to see 200 adult caimans on the banks of the River Ariari and elsewhere in Colombia, but within a few years, they had disappeared (Anon. 1981). In the 1950s and early 1960s, 6 to 8 million skins were traded per year, resulting in the near-extinction of the American Alligator and many other crocodilians (King 1994). One Brazilian state exported 5 million hides in 1950 (King 1994), and in that year 12 million Black Caiman (*Melanosuchus niger*) skins were taken from the Amazon basin (Fitzgerald 1989). By the late 1960s, Brazil and many South American countries had prohibited export of wildlife. The Black Caiman, a member of the Alligatoridae family, was listed on CITES Appendix I in 1975, along with most other large crocodiles, members of the family Crocodylidae. This designation officially bans international commercial trade among member countries.

Combined with CITES protection, these trade restrictions allowed some species to recover, but much of the trade went underground, involving the smuggling of hundreds of thousands of caimans poached in Colombia, Venezuela and Brazil. The skins were hidden in shipping crates, or transshipped from other countries. Paraguay, in spite of its export ban, was a major conduit for illegally taken wildlife, and remains so today. Another species that was highly sought after for its soft skin was the Broad-snouted Caiman (*Caiman latirostris*). This crocodile also became endangered from the trade and is on Appendix I, but during the 1980s, a black market for its skins was uncovered in West Germany, supplied by 20,000 skins poached annually in Brazil (Fitzgerald 1989). In 1980 alone, a Frankfurt, Germany, company imported--under false documentation--some 200,000 caiman skins of various species from

Paraguay (Fitzgerald 1989). Many caiman skins came from the Pantanal, a vast wetland in western Brazil that once teemed with these reptiles.

Approximately 85 percent of the world's crocodilians became endangered by the reptile product trade of the 1950s and 1960s. New World species were especially targeted. Besides the South American Black and Broad-nosed Caimans, two subspecies of the Spectacled Caiman (*Caiman crocodilus*)--the Yacare Caiman (*Caiman crocodilus yacare*) and the Apaporis River Caiman (*Caiman crocodilus apaporiensis*)--declined so precipitously that they were listed on both the U.S. Endangered Species Act and CITES Appendix I. Exploitation of the remaining subspecies of Spectacled Caiman continues, however. Identification of reptile products by subspecies is nearly impossible, thereby preventing proper protection of this species. In 1986 alone, the United States imported more than 65,000 Spectacled Caiman skins and more than 530,000 caiman handbags, shoes and other leather products (Fitzgerald 1989). A large portion of the trade in Spectacled Caiman is illegal, with violations including the poaching of endangered Yacare from Paraguay and caimans from national parks and other protected areas.

Other endangered New World species include the American Crocodile (*Crocodylus acutus*), whose range includes the Florida Keys; the Cuban Crocodile (*Crocodylus rhombifer*); Morelet's Crocodile (*Crocodylus moreletii*) of Mexico, Belize and Guatemala; and the Orinoco Crocodile (*Crocodylus intermedius*) of Colombia and Venezuela. All the latter species are listed as endangered on the U.S. Endangered Species Act. An additional 10 species and subspecies from Africa, Asia and the Philippines are also listed on the Act. Fifteen species of crocodilians are listed on Appendix I of CITES. All other alligators and crocodiles are listed on Appendix II.

Many of the CITES listings include exceptions that allow trade in some populations or subspecies. Also, some crocodile species are ranched, or raised in captivity expressly for commercial slaughter, in South America, Africa, Madagascar, Australia and Asia. Eggs laid by wild crocodiles are taken to supply these farms, and a percentage of the young crocodiles are released back to the wild. In Brazil, for example, the Yacare, an endangered subspecies of crocodile listed on the U.S. Endangered Species Act, is being exploited for the reptile products trade through ranching. Licenses are granted by the government to remove eggs based on the number of nests on each property. The eggs are hatched and raised in captivity, and 10 percent of the 1-year-old Yacares are returned to the wild (Bampi and Dal'Ava 1994). Through this ranching, 80,000 crocodile hides were produced between the 1992 and 1994 seasons (Bampi and Dal'Ava 1994). Brazilian Government officials maintain that in nature, fewer than 10 percent of the young would survive and, therefore, this is an environmentally benign activity (Bampi and Dal'Ava 1994). These animals, however, produce hides that are different from wild Yacare (Bampi and Dal'Ava 1994) and may differ in many other respects from their wild counterparts. They have been raised in unnatural conditions, and captive-raised crocodiles may not be able survive in the wild. The natural selection of crocodile egg and hatchling survival is also interfered with, negating the "survival of the fittest" principle with the possible effect of weakening the species. Another effect of ranching programs is the role that newly hatched crocodiles and alligators play in food chains; they provide a major food source for many waterbirds and are fed on by a variety of animals. By removing a large percentage of wild crocodilian eggs of a species, adverse ecological consequences may result.

A major trade in American Alligator hides began in the 1950s, and in the 1960s, state laws were passed banning killing and trade because of steep declines in its populations. In 1973, it was listed on Appendix I of CITES. In 1979, the species was removed from CITES Appendix I and placed on Appendix II, allowing trade. The federal U.S. Endangered Species Act originally listed it as Endangered, but reclassified it as Threatened throughout its range in the Southeastern United States under the Similarity of Appearance clause. Under this designation, some states may harvest Alligators. Louisiana supplies the largest number of skins, and also farms this species. The meat is also marketed in restaurants. Many Alligators that wander out of national parks and reserves are immediately killed as pests and threats to humans, and their skins are sold. In Florida, private companies respond to citizen calls about Alligators being present in waterways, and they send personnel in vans to capture and kill all Alligators over a minimum size limit, whether or not they present a threat. Although alligator hides entering trade must be marked by the U.S. Fish and Wildlife Service as legally taken according to management regulations, shipments are rarely inspected, and once out of the country and turned into handbags and shoes, their legality cannot be verified.

After 25 years of legal protection, about one-third of all alligators and crocodiles, or eight species, have increased their populations (King 1994). Many of the latter species are reentering trade, and advocates for the trade are stating that they are now "harvestable" (King 1994). This is being called a great conservation success, in spite of the fact that two-thirds of the species remain critically endangered, or "safe" but unharvestable (King 1994).

The incentive is high to poach crocodiles for this luxury trade. Crocodile handbags sell for as much as $3,000. Briefcases can cost $10,000 or more. Major markets for these products have been Tokyo, Singapore, New York, Los Angeles, Frankfurt, Berlin and Rome. By purchasing crocodilian products, one may be contributing to the overexploitation of a species, or unknowingly buying an endangered species product. Moreover, crocodilians have an important ecological role to play in nature. Adult crocodiles and alligators are at the top of their food chains. They weed out overpopulated fishes, including the voracious piranha, and dig water holes in times of drought that save the lives of numerous animals. In fact, when populations of South American caimans were decimated in the 1960s, piranhas increased to epidemic proportions. They also present a wildlife spectacle when large groups of caimans sun themselves on river banks, and are one of the prime attractions for ecotourists who travel to the tropics. If calculations were made of their value in ecotourism and in ecological systems, they would be considered worth more alive than dead.

Reptile Trade: Lizards and Snakes

The use of lizards in the reptile products trade began growing when crocodiles declined and became protected. Millions of Red Tegu (*Tupinambis rufescens*) lizard skins, exported from Argentina, have been used in the exotic leather trade. Heavy exploitation of this species and the Common or Banded Tegu (*Tupinambis teguixin*) of South America caused an overall decline in populations throughout their range (Fitzgerald 1989). All tegu lizards, *Tupinambis* spp., are listed on CITES Appendix II. Several Asian monitor lizards, extremely large reptiles including the world's largest lizard, the ten-foot-long Komodo Dragon (*Varanus komodoensis*), are listed on CITES Appendix I. The Bengal Monitor (*Varanus bengalensis*), Yellow Monitor (*Varanus flavescens*) and the Desert Monitor (*Varanus griseus*) are all endangered species. When they were added to Appendix I in 1975, Japan refused to abide by the listing and filed a reservation on these lizards, not lifted until 1994. All other monitor lizards (*Varanus*), which occur in Asia, Australia and Africa, are listed on Appendix II of CITES. In spite of the latter listing, African monitor lizards are killed in very large numbers for the reptile products trade.

The Caiman Lizard (*Dracaena guianensis*) is listed on Appendix II of CITES because it is threatened by exploitation, along with related lizards of its genus. In 1995, skins and boots of this species worth $1 million wholesale were confiscated from the Tony Lama Boot Company of El Paso, Texas, by the U.S. Fish and Wildlife Service. Among the seizures were 907 pairs of Caiman Lizard cowboy boots and 2,554 pairs of boot vamps. A 15-count felony indictment for smuggling and violations of the Lacey Act was issued by a Grand Jury against two people who sold the skins to Tony Lama, using fraudulent export permits obtained in Mexico. The Lacey Act prohibits importation-- without permits--of species protected in their country of origin. This lizard is native to the Amazon Basin, and its lustrous skins are highly prized for boots, which can retail from $700 to $1,000 per pair. Four lizards are used to make one pair of boots. More than 13,800 Caiman Lizards were killed and sold to the Tony Lama Boot Company for the manufacture of the boots and skins seized. The indictment was the result of an undercover investigation by the Fish and Wildlife Service, begun in 1993.

Millions of snakes are killed for the reptile product trade, mainly in Asia. Indian Whip Snakes (*Ptyas mucosus*) and Oriental Water Snakes of the family Acrochordidae are heavily exploited. In the late 1970s, India supplied more than 3 million snake skins. India listed the Indian Whip Snake on Appendix III of CITES in 1984, indicating that it was protected by national law. After this export ban, a single government company held 5.7 million snake skins

which it exported in what was supposed to be controlled trade; smugglers removed thousands of snakes from India illegally, however (Fitzgerald 1989). The Indian Government made a seizure of one such smuggling operation with 150,000 snake skins destined for West Germany (Fitzgerald 1989). This system of controlled trade did not succeed in ending India's exports, since the stockpile actually grew to 6 million skins by 1979, after exports of hundreds of thousands of skins from this supposed stockpile (Fitzgerald 1989). Wild Whip Snakes continued to be killed and added to this stockpile, causing population declines and increases in grain-eating rodents.

Pythons are among the most popular snakes for shoes and handbags, and one subspecies of Indian Python (*Python molurus molurus*) is listed on CITES Appendix I, while other subspecies enter trade. This listing is totally ineffectual because of confusion with other subspecies of this snake. All pythons (*Python* spp.) are listed on Appendix II, but this has done little to slow the trade in their skins. The massive take of wild pythons in Asia for shoes, handbags, and even clothing has resulted in infestations of rats, which spread disease to humans and damage crops. Peter Brazaitis, a herpetologist and former curator of animals at the Central Park Wildlife Center in New York City, commented: fiI think we have to ask ourselves, what is the value of a python? Is it as a pair of expensive pants? Or is it as a means to check exploding rat populations in nations where communicable diseases are rampant? (Chivera 2000).

Likewise, Argentine Boa Constrictors (*Boa constrictor occidentalis*) are listed on CITES Appendix I, and other subspecies on Appendix II. Once made into reptile products, races of Boa Constrictor resemble one another, making the CITES listing meaningless. The largest Boa Constrictors, which are the oldest, have been a prime target for skin hunters in South America, and the enormous snakes of this species, once commonly seen in tropical forests, have disappeared as a result of this trade. Many are also taken for the pet trade. Retail prices indicate the popularity of snakeskin for luxury leather goods. A python handbags sell for $300 or more, and a python belt costs $120.

Lizards consume large quantities of insects and are extremely vital to ecosystems. Reptiles play an important role in nature, and the killing of millions of these useful animals is disrupting the balance of nature in many parts of the world.

The luxury reptile leather trade has pushed many species toward extinction, and it shows no signs of declining. Lizard and snakeskin products are now being sold in the volume that turtle and crocodilian leather once were. Handbags, wallets and shoes from these reptiles can be seen in department and shoe stores throughout the world. The endangered reptile species of tomorrow can be seen in the advertisements and luxury shops of today.

Traditional Medicine Trade

The Traditional Medicine (TM) trade has been disastrous to many species of wildlife. Even highly endangered species listed on CITES Appendix I continue to be killed to supply this huge market in southeast Asia and in Chinese communities around the world. In many cases, enforcement is impossible because endangered animals are sold in forms difficult to detect by Customs officials, such as powder made from ground bones. The majority of potions sold in this trade have substitutes from non-animal sources, and many do not cure the diseases they claim to, nor do they restore male potency. Yet the return to a capitalist economy in China and the relative wealth of many Asians has placed such high prices on the heads of rare animals that many species may not survive. This would mean the end of some of Earth's most magnificent animals. Among these is the Tiger, whose bones and body parts are highly prized and extremely valuable in the TM trade. All five species of rhinoceros are teetering on the edge of extinction, with this trade a major cause. While hundreds of rangers in Asia and Africa have lost their lives protecting Tigers and rhinos, and many government officials and conservationists have struggled fervently to stop the slaughter, bureaucratic indifference and weak enforcement have combined to negate conservation work in many markets. Internal trade bans on these animals have recently been enacted by China and Taiwan, but enforcement is not strong. Many of the animal products are intended to increase male potency, and a recent drug marketed in the West, Viagra,

may reduce demand for wildlife products such as Tiger and seal penises that have been sold at high prices for this purpose in the past. In fact, the market for seal sexual organs has already collapsed, resulting in a huge decline in the number of Harp and Hooded Seals killed in Canada, from 280,000 in the late 1990s, primarily for this market, to 91,000 in 2000 (Nickerson 2001). The price paid for seal has dropped from $25 per animal to a few dollars, if a buyer can be found (Nickerson 2001). This is good news for some animals, but many others are killed to make products for other purposes, such as to lower fevers, treat rheumatism and heart disease and promote general vigor. Several organizations and national governments are combating the killing of rare animals for this trade through education programs which provide information on effective alternative medicines.

A 19th century victim of the Traditional Medicine trade was Schomburgk's Deer (*Cervus schomburgki*). Discovered in eastern Thailand in 1862, no European ever saw the species in the wild (Day 1981). They were heavily hunted for their large and many-tined antlers that supposedly possessed medicinal and magical properties (Day 1981). In the mid-19th century, herds of Schomburgk's Deer were seen in swamps, and during floods, they were pursued by boat, marooned on small islands, and speared (Day 1981). When swamp drainage and irrigation added to their threats, they retreated to bamboo jungles, to which they were not well adapted, until these, too, were cleared for rice fields (Day 1981). The last known Schomburgk's Deer was shot by a policeman in September 1932 (Day 1981). The species was considered extinct and officially listed as such by the IUCN (WCMC 1993). In 1991, a pair of antlers from an unknown type of deer was seen by Laurent Chazee, an agronomist with the United Nations, in a Traditional Medicine shop in a remote part of Laos (Schroering 1995). Chazee photographed the antlers, which were later identified as coming from a Schomburgk's Deer; the shop owner told him that the animal had been killed the previous year (Schroering 1995). Forests nearby may shelter more of these deer, and the site is considered by local people to have sacred animal spirits; hunting is prohibited there (Schroering 1995). A shop in Phnom Penh, Cambodia, in February 1994 offered antlers of what were represented as Schomburgk's Deer for $10 a pair (Martin and Phipps 1996). The seller was obviously unaware of the extraordinary rarity of this deer. There is still no proof that the species survives, and it has been listed as extinct in *2000 IUCN Red List of Threatened Species*.

Rhinoceros horn, Tiger bone, ground deer antlers, gallbladders from many species of bears, musk glands from deer, and softshell river turtles are among the thousands of raw materials for Traditional Medicine. This trade has pushed a host of magnificent species precipitously toward extinction within the past few decades. Many were already rare from persecution, hunting and habitat loss. While these products have played an important role in Traditional Medicine for centuries, only within the past decade has the trade spiraled out of control, with a potential market of more than 1 billion people. A recent survey of Cambodia's markets found the products and body parts of numerous endangered species, including Asiatic Black Bear, Sun Bear, Tiger, Leopard and many rare and endangered deer and wild cattle, being openly sold (Martin and Phipps 1996). Civets, cat-like mammals, are roasted and their meat sold in the winter to warm blood (Schaller 1993).

Obviously, all the remaining wild rhinos, Tigers, Musk Deer, bears and other animals used by this trade cannot fill the demands of this enormous market. This trade has proven the most difficult in the world to control. Even the threats of international sanctions, strict national laws and CITES Appendix I listing of most of the species involved have not stopped it.

Snakes by the thousands are kept alive in Asian markets, offered as fever cures and tonics. When a customer selects one, it is hung up still squirming, and the gallbladder is cut out. Some are skinned alive, and customers drink the blood. In Cambodia, great numbers of snakes are sold, and at one market alone 4.4 tons of pythons were sold in 1993; cobras are shipped live by the thousands to Vietnam (Martin and Phipps 1996). A mongoose is often kept next to the snake cages to keep them angry and lively. In Taiwan's capital city, Taipei, a vast marketplace called "Snake Alley" sells thousands of live snakes in this fashion.

Primates, Pangolins and Fruit Bats
Dolphins and Seals
Saiga and Deer

Tigers
Rhinoceros
Bears
Sturgeon
Seahorses

Traditional Medicine Trade: Primates, Pangolins and Fruit Bats

Slow Lorises (*Nycticebus coucang*), nocturnal primates with huge eyes and thick fur, are gentle and shy tropical forest dwellers. Thousands are captured in Southeast Asia for Traditional Medicine. They are killed and cooked in lemon leaves in China to provide tonics. In Cambodia, hunted with crossbows, they are among the commonest wild animals sold in markets, with racks of hundreds of dried lorises exhibited for the buyer (Martin and Phipps 1996). Live lorises are often sold in Chinese markets to be killed later, or kept as pets. These nocturnal animals suffer in the bright daylight, blinking and cowering in their tiny cages. Educators from the Wildlife Conservation Society (WCS), headquartered in New York City, visited a Chinese market in Yunnan province with local schoolteachers to show them the many endangered species being offered for sale, and saw two threatened Pygmy Lorises (*Nycticebus pygmaeus*). A mother and her young cringed in a tiny wire cage with barely enough room to turn around; the mother loris wrapped her body around her tiny infant, shielding it from the noise and dazzling sunlight (Naiman 1997). In all likelihood, they would die from malnourishment, disease or dehydration, and one teacher suggested that the educator buy them to save their lives, but the WCS representative believed that this would only have resulted in more lorises being captured. This species is considered Vulnerable, a category for species only slightly less threatened with extinction than endangered species, by the *2000 IUCN Red List of Threatened Species*.

The very rare and beautiful Golden Monkey (*Rhinopithecus roxellana*) is killed so that its brain may be used for Traditional Medicine. Macaques from Southeast Asia are being captured in Vietnam and shipped across the border to China, where they are kept alive in tiny wire cages and killed on order for the Traditional Medicine trade.

Pangolins, scaly armored mammals of Africa and Southeast Asia are so heavily hunted for their scales, which are used in various remedies, that all three species (*Manis* genus) are now listed on Appendix II of CITES.

Fruit bats are collected in Southeast Asia for sale in Traditional Medicine markets. The BBC filmed their capture for a PBS Nature special, fiCastaways of Sulawesifl (1995). In Sulawesi, Indonesia, the island formerly known as Celebes, young boys fly kites with hooks that entangle the fruit bats as they fly off to feed in the evening. The fruit bats scream and squeal as they are hauled in and placed in boxes with rods for perches. Trappers ship them for four days, often without food or water in extreme heat, to tradesmen who kill them for use in Traditional Medicine. This trade is having a disastrous effect on the island's fruit bats. The loss will be significant if these bats are eliminated, because of their enormous value as pollinators of numerous species of trees, many of which provide economically important fruit. Fruit bats and flying foxes throughout Asia and the Pacific are killed for food and TM. Nine species of fruit bats have been placed on Appendix I, and the entire genus *Pteropus* of flying foxes on Appendix II of CITES, but this has had little effect on the trade.

Traditional Medicine Trade: Dolphins and Seals

Ganges River Dolphins (*Platanista gangetica*) of the Ganges and Brahmaputra River systems in India, Bangladesh, Bhutan and Nepal, are extremely rare throughout their range, with a total population that may number only about

2,000. In Nepal, where there are fewer than 100 animals, fishermen net them to sell their flippers for the TM trade which uses the bone for gastric problems. Appendix I listing has not stopped trade because Chinese authorities have failed to enforce it strictly. It is listed as Endangered on the *2000 IUCN Red List of Threatened Species*.

Once common in the Amazon and Orinoco River systems from eastern Brazil to the Andes of Peru and Bolivia, Pink or Amazon River Dolphins (*Inia geoffrensis*) have disappeared from most of this region. A 1995 film, fiLegend of the Pink Dolphin,fl on National Geographic Explorer, depicted the species as threatened or endangered in all but the most inaccessible areas and described the bizarre trade in its body parts. A book on the subject, *Journey of the Pink Dolphins. An Amazon Quest* (Montgomery 2000), is an in-depth study of the people and their relationship with these dolphins. Shantytowns established on riverbanks built when forest clearance forced many people out of their traditional regions, have been the center of the illegal hunting of these dolphins. Many of the residents of these towns kill the gentle Pink Dolphins for their body parts, which are considered magical. Some fishermen drown them on purpose, and others accidentally. Many people in the Amazon believe that these dolphins can impregnate women, and others buy body parts, such as the left eye, penis, teeth and head, as good luck charms. Entire baby dolphins are sold in these towns as charms. Roxanne Kramer, an American biologist who has studied these animals since 1984, has become an active conservationist on their behalf. She found jars of Pink Dolphin eyes being sold in local villages for $1.50 per eye in 1995, and estimates that in Brazil alone, more than 100 Pink Dolphins are killed a month just for their left eyes, considered to have magical properties. Dolphin corpses that have been mutilated now wash up on riverbanks their heads removed. Roxanne and another biologist, Fernando Trujillo, have conducted separate campaigns to persuade local people not to kill these dolphins, but at the present rate of loss, they may soon disappear altogether.

The decline in the seal hunt in Canada will mean a decrease in extreme cruelty that has been documented by various witnesses. The Earth Island Institute's *Journal* reports that in a 1994 hunt, seal pups' skulls were crushed, they were strangled with nooses, and in one case, a mother Harp Seal was beaten with the body of her screaming pup. When Paul Watson of the Sea Shepherd Conservation Society protested the hunt in early 1995 in the Gulf of St. Lawrence's Magdalen Islands, 150 angry sealers broke down the door to his hotel room. He was saved by police, who rushed him into a police cruiser, according to wire service accounts. Other seals, such as South African Fur Seals (*Arctocephalus pusillus*), are killed both for their pelts, which are sold to European furriers, and their penises for the TM trade. As described above, many thousands of young male seals are killed each year. Hopefully, this hunt will decline as well.

Traditional Medicine Trade: Saiga and Deer

The horns of Saiga antelope (*Saiga tatarica*), a species being slaughtered by the hundreds of thousands in Russia and Central Asia, are thought to cure many illnesses; in 1990, China imported 80 tons (Schaller 1993). This curious species has become so threatened by this trade that it was listed on CITES Appendix II at the 1994 Conference. The Saiga once numbered in the millions in the Central Asian steppes, an ecological equivalent of the American Bison or African Wildebeest, but were slaughtered to near extinction during the 19th century.

A trade study found that in 1994, 44 metric tons of Saiga Horn were exported illegally to China, South Korea, Japan and some European nations. One metric ton is equivalent to 5,000 horns; horn sold for as much as $30 per kilogram in East Asia (Chan *et al*. 1995b). In a random survey in August and September 1994, TRAFFIC International investigators found Saiga horn in 131 shops in Hong Kong, from an estimated 15,000 animals. Taiwan banned the sale of Saiga horn in 1994 (Chan *et al*. 1995b). Populations of this species have declined in Kazakhstan and Kalmykia and have become endangered in Mongolia. Today, the trade in Saiga horn is so uncontrolled and massive that it threatens the species' future survival (Chan *et al*. 1995b). The status of the Saiga declined rapidly between 1994 and 1996. The 1994 edition of the *IUCN Red List* included only the Mongolian subspecies (*Saiga*

tatarica mongolica), but in the 1996 list, the entire species was listed as Vulnerable; two subspecies, the Mongolian was listed as Endangered, and the Russian (*Saiga tatarica tatarica*) was listed as Vulnerable. The *2000 IUCN Red List of Threatened Species* classified the Saiga as Conservation Dependent, with the Mongolian race Endangered, and the Russian also Conservation Dependent. (For more on the Saiga, see Grasslands, Shrublands and Deserts chapter; and in the Video section, Mammals, fiThe Saiga of Kazakhstan.fl)

Asian Red Deer (*Cervus elaphus*), known in North America as Elk, have been heavily exploited for their antlers to use in the TM trade, and many races are endangered. The *2000 IUCN Red List of Threatened Species* lists five subspecies or races of the Red Deer native to China. The Yarkand Deer (*Cervus elaphus yarkandensis*) is listed as Endangered, and the other races are in lesser categories. The U.S. Endangered Species Act lists McNeill's Deer (*Cervus elaphus macneillii*) of Sinkiang and Tibet, and the Shou (*Cervus elaphus affinis*) of Tibet and Bhutan as Endangered. The Chinese Shou is on the brink of extinction, a tiny population having been rediscovered in a park in Lhasa, Tibet in 1988. The Yarkand Deer is considered probably extinct by *Mammals of the World* (Nowak 1999). Another Chinese race, the Kansu (*Cervus elaphus kansuensis*), is endangered by hunting. The Tibetan Red Deer (*Cervus elaphus wallichi*), which possibly exists in Bhutan and Tibet, and the Alashan Wapiti (*Cervus elaphus alashanicus*), endemic to China, are both possibly threatened. Shops in cities in Yunnan Province, China, visited in 1997, were selling numerous body parts from Red Deer including the velvet from antlers, a fetus, blood, tails, ligaments, genitalia, hooves and antlers (Li and Wang 1999). They also found similar items from other Asian deer.

A threatened species of deer, Eld's Deer or Thiamin (*Cervus eldii*), which ranges from India to Southeast Asia, is a CITES Appendix I species. A survey in Cambodia found 14 sets of Eld's antlers being offered for sale in 1994 at $150 to $200 a pair (Martin and Phipps 1996). The survey in Yunnan Province in 1997 also uncovered body parts from these threatened deer (Li and Wang 1999). Wild Asian deer are being slaughtered without restriction for commercial sale. One shop in Lomphat, Cambodia, reported receiving 100 to 300 whole Sambar deer (*Cervus unicolor*) and other deer per month, their antlers selling for $200 to $300 per set (Martin and Phipps 1996). Cambodian officials reported that Eld's Deer and Sambar are usually hunted with dogs in the wake of forest fires, which are sometimes started deliberately, or with torches at night (Martin and Phipps 1996).

Endangered wild cattle horns were also seen in Cambodian shops. Banteng (*Bos javanicus*), a statuesque species of wild cow verging on extinction throughout its Southeast Asian range, is still being killed for its horns and meat. A pair of horns on the skull were offered in Poipet market, Cambodia, in February 1994 (Martin and Phipps 1996). A skull with horns of Gaur (*Bos gaurus*), largest of the wild cattle and nearly as endangered, was seen for sale in the same market for $40. Rarest of all wild cattle, the Kouprey (*Bos sauveli*), has been considered nearly extinct in the forests of Cambodia and possibly Laos and Vietnam (Baillie and Groombridge 1996). Yet a shop in the Poipet market, Cambodia, offered a Kouprey skull, a female with horns, for $400 in February 1994 (Martin and Phipps 1996).

Five species of Musk Deer inhabit high-altitude forests from 2,600 to 3,600 meters. Ranging from Afghanistan to Siberia, and south to Vietnam and Myanmar, all species have declined as a result of hunting for their musk glands. The musk is used in Traditional Medicine, and buyers for Asian markets offer huge sums of money for the glands and for the pouch containing this valuable liquid. Their musk is also valuable in the perfume trade, worth $65,000 per kilo (Fitzgerald 1989). Male Musk Deer mark their territories with the musk. Females do not have this gland, but snares set for these deer kill females and fawns along with the males. These once common and widespread deer have became rare or endangered throughout their ranges, especially in China, the Himalayas and Siberia (Nowak 1999); they suffer the additional pressure of habitat loss as their forests are stripped for firewood. Although there are musk deer farms in China, very little musk is produced, encouraging the wholesale slaughter of wild deer (Schaller 1993). They are known to be difficult to breed in captivity (Fitzgerald 1989). One species, the Siberian Musk Deer (*Moschus moschiferus*), native to mountains of China, Korea, Mongolia and Far Eastern Russia, has declined to endangered status as a result of this trade and is listed on Appendix I of CITES.

In 1987, 800 pounds of musk worth $14 million were smuggled out of China, the product of 53,000 male deer.

More than 100,000 deer had been killed in the quest for these glands, since many of the dead deer were females and young which were discarded. The glands were exported to Japan (Schaller 1993). An average of 700 pounds of musk are sold in world markets each year, much of it going to Hong Kong, the international center for musk; Japan is a major consumer, using musk to treat a variety of illnesses (Fitzgerald 1989). Between 1974 and 1983, Japan imported between 250 and 700 pounds of musk per year, worth an average of $4.2 million; imports increased in 1987 to 1,800 pounds, an all time high, and sold for $32,468 a pound! (Fitzgerald 1989). French perfumes known to use musk include Chanel No. 5 and Madame Rochas (Fitzgerald 1989). From 1990 to 1994, half of Russia's musk deer were killed by poachers, and their glands were smuggled into northeastern China and South Korea (Galster 1996). A 1997 survey found that stores in southern Yunnan sold musk and medicine from these deer (Li and Wang 1999). Musk and medicine from it from three other species of musk deer were also seen in this survey. Musk deer native to Afghanistan, Bhutan, India, Myanmar, Nepal and Pakistan are listed on CITES Appendix I, while other species and populations are on Appendix II. Such listing is completely illogical in terms of enforcement, since only the glands are traded and cannot be identified as to species or population.

Musk deer (genus *Moschus*) are so different from other deer that some scientists place them in a separate family, the Moschidae (Nowak 1999). These small deer resemble hares because of their large hindquarters, the shape of their heads, and their long, thin legs. These are the only deer that climb low trees to feed on leaves, mosses and nuts (Grzimek 1968).

Traditional Medicine Trade: Tigers

The magnificent Tiger, largest of all cat species, may be driven to extinction because its body parts are in such demand in the Traditional Medicine trade that it is pursued and killed even in sanctuaries and national parks. The illegal trade in Tigers grew astronomically in the 1980s concurrent with the burgeoning of economies in many countries in Southeast Asia, and it continues at uncontrolled levels. These endangered animals are no longer safe, even in the remotest parts of their range. Fewer than 5,000-- and many believe that as few as 3,000--remain (Matthiessen 1997). Most experts say they will not survive in the wild more than a few decades at the present rate of killing, which is calculated at one Tiger a day for this market (Jackson *et al*. 1996).

This species has lived on Earth for at least a million years, and until the 20th century, its range covered most of Asia. During the Pleistocene Age, when sea levels were low, Tigers colonized Indonesian islands and Japan, spreading into almost every habitat except deserts (Matthiessen 1997). Thousands of years ago, warriors in Central Asia and China killed Tigers in shows of manhood, which are depicted in works of art. Even in 1900, an estimated 100,000 Tigers roamed from eastern Turkey to Russia's Far East, and south to Bali in Indonesia. Since the turn of the century, an estimated 95,000 Tigers have been killed. These great cats have played an important role in the mythology, art, culture and even religion of cultures throughout Asia. Their courage, even when cornered and trapped, has contributed to the almost mythic role in which Tigers have been cast. This is a major reason many practitioners of TM believe that Tiger body parts will impart virility and restore health to those consuming them.

Traditional Medicine practitioners use nearly every part of Tigers, from their whiskers to their eyes, claws, pelts, flesh and bones. Their bones are ground into a powder that is used to manufacture "Tiger Bone Wine," of supposed medicinal value, and elixirs from ground Tiger bones are used to treat rheumatism, convulsions, scabies, boils, dysentery, ulcers, typhoid and malaria (Ward and Ward 1993). There are medicinal substitutes to treat all these maladies. The male's penis is made into soup, said to give potency, for rich Asian businessmen who pay as much as $18,000 for a dinner featuring it (Highley and Highley 1994). The trade continues because of the ingrained and widespread beliefs by the Chinese and many other Asians in traditional potions. The Chinese government encouraged the trade by sponsoring Tiger-bone medicine production until mid-1993 (Schaller 1993), and evidence indicates that the trade continues today without interference from Chinese authorities.

Tiger medicine products are marketed in China, Southeast Asia, and in Chinese pharmacies throughout the world. All of this trade is illegal under most national laws and CITES, but enforcement in Southeast Asia is weak. Because the Tiger bone is sold in powder form, it can be traded surreptitiously, even in countries with strict wildlife laws.

Not only are Tigers being killed in great numbers, but they are dying cruelly. Poisoned meat is spread in national parks in India that kills slowly and painfully. Pesticides, such as the toxic Aldrin, are placed in buffalo or cow carcasses already killed by a Tiger, to poison the Tiger when it returns to feed; sometimes water pools are laced with poison (Currey 1996). Steel jaw leghold traps and wire snares, which maim and slice through the flesh, are set in forests throughout its range. In Russia, they are trapped or pursued by howling packs of dogs. Tigers have been filmed as they were being killed by a knife inserted into the throat while strung up spread-eagled, all four legs stretched apart by tight ropes. Females have been shot and their cubs left to starve to death. Dealers in poached Tigers now employ villagers to kill Tigers for a fee, supplying the villagers with poison and traps. In the 1970s, bold Tigers lolled in national parks for tourist cameras, but today they have either disappeared or become frightened, nocturnal hunters.

Should the Tiger disappear, a remarkable animal will have been lost. The male Siberian, largest subspecies of Tiger, can reach 6 feet in length, with a tail another 3 feet long, and weigh more than 670 pounds, while females weigh about 360 pounds and are smaller in stature (Nowak 1999). The Lion, second largest cat, weighs--at most--550 pounds, well under the weight of the Siberian male (Nowak 1991). Its immense strength enables it to carry large deer for long distances and up into high trees. Tigers are able to leap vertically 10 or more feet while carrying a deer. Tiger mothers are extremely devoted to their cubs, which number up to four per litter. Cubs remain with the mother for almost two years, requiring a long apprenticeship to learn to hunt and survive in the wild. In some cases, cubs do not become independent until they are 3 years old (Nowak 1999). About half the cubs die in their first two years, but adult Tigers have a low natural mortality, with a potential longevity of 26 years (Nowak 1999).

The 20th century was witness to a drastic reduction in the numbers and ranges of the Tiger. It was eliminated in vast areas with the growth of human populations and the spread of cities, and when guns came into common use, its long tenure as the supreme predator was over. Wilderness areas that provided refuge in Central Asia and Russia became the domain of livestock, and prey species were hunted out by local people. In the absence of natural prey, Tigers killed domestic livestock, becoming the object of unregulated slaughter. Added to this, they were a great prize for trophy hunters, and killing for Traditional Medicine in Southeast Asia caused them to disappear from vast areas. Gone from Java, Bali, East Asia and most of its remaining range in Asia, it is probably extinct in south China and close to extinction in Sumatra (Matthiessen 1997). The Indonesian government admitted at an October 1995 Asia Regional Meeting of CITES that poaching of the Sumatran Tiger was "uncontrolled" and "overwhelming" (Jackson *et al*. 1996).

Education programs have been launched to discourage the use of Tiger products within China, attempting to kindle conservation zeal among the Chinese people. Jackie Chan, the star of many action films, volunteered to do Public Service Announcements discouraging the use of Tiger products. But the resistance is strong. A Traditional Medicine practitioner commented angrily to CNN news in July 1996 that laws against the use of Tiger products were thwarting his practice. American conservationists in the southern province of Yunnan found Tiger bone pills being sold in markets in 1996, in spite of legal prohibitions (Naiman 1997), and they were still being sold when another survey was taken in 1997 (Li and Wang 1999). The Kumming Zoo in the province has a "Tiger Shoot," an arcade game in which a player aims a model rifle at a target bearing the image of a Tiger. Speakers attached to the rifle amplify the sound of its firing, and a counter keeps score (Naiman 1997). This describes, in a nutshell, the attitudes that have pushed the Tiger to near-extinction in China and are providing the market that is killing hundreds of Tigers.

An investigation of Cambodian markets in 1994 and 1995 found Tiger products being sold in many cities. In one market alone, the bones and other body parts of an estimated 33 to 43 Tigers were found (Martin and Phipps 1996). Very large Tigers have been reported from Cambodia, with bones weighing almost double those of the average Tiger

(Martin and Phipps 1996). Prices in Phnom Penh have risen in the 1990s from $80 per kilogram of bone to $250, and live Tigers are sold for $200 to $250 each; these Tigers are sent to Vietnam, where they can be sold for as much as $5,000 each prior to their slaughter (Martin and Phipps 1996). A 1995 workshop estimated populations in Vietnam at only 150 to 300, with another 300 in Cambodia (TRAFFIC 1995). The same year, Cambodia announced that two to three of its Tigers were being killed per month (Jackson *et al*. 1996). Tiger skins and body parts were offered for sale in November 1995 in Poi Pet, a town on the Cambodian-Thai border, with two large skins stretched out next to leopard pelts. This was only eight months after Cambodia had pledged at a World Wildlife Fund workshop to clamp down on the trade (Jackson *et al*. 1996). In January 1996, Tiger skins and products were still being openly sold in Phnom Penh, Cambodia, an indication that enforcement is not taken seriously in this country. The government of Cambodia granted logging concessions on 6.5 million hectares of forest land. This country still has sizeable forests, unlike Thailand, whose ancient teak forests were clearcut during the 1970s and 1980s. Burma is also opening its forests to logging, and once these forests are gone, the Tiger will have little habitat left in Indochina. In the process of constructing logging roads and opening the forests, hunters will enter and pursue the last Tigers in the region.

Throughout Indochina, wildlife is being decimated. According to biologists Alan Rabinowitz and George Schaller of the Wildlife Conservation Society, "People are literally wiping out everything--sambar, barking deer, even young elephants. The forests look good, but there are no Tigers because there is nothing for them to eat" (Matthiessen 1997). Alan Rabinowitz (1999) has spent years in the region and has documented the open sale of Tiger parts in towns and cities throughout the region. He found that Tigers remain mainly in isolated blocks of forest, and poaching is the most insidious threat to these populations; no effective Tiger management policies have yet been designed or implemented in Indochina (Rabinowitz 1999). Trade has increased since 1990 and occurs at local, regional and international levels, made more difficult to control by the political chaos in several countries and the fact that Laos is not yet a Party to CITES. Rabinowitz (1999) placed such importance on the effects of the trade that he concluded, "If the trade in tiger and other wildlife parts cannot be effectively controlled, the protection and management of tiger populations will become an almost insurmountable task in most range countries."

India's 23 Tiger Reserves lost 35 percent of their Tigers between 1989 and 1993, and at least 600 were killed between 1990 and 1994, according to the BBC film *Tiger Crisis* and *Time* reporter Eugene Linden (1994). Low fines and corruption among some wildlife enforcers and judges mean that such crimes, even when they result in arrests and indictments, are usually dismissed (Currey 1996). Despite the fact that hundreds of poachers and traders have been caught red-handed, they escaped conviction of Tiger-related offenses until very recently (Kumar and Wright 1999). Many cases of Tiger killing do not even result in arrests when corrupt park rangers accept bribes from poachers. Assam, a reserve with 90 Tigers lost almost half of them in just four months in 1994 (Linden 1994). The Indian government announced in October 1995 that it had seized 1,000 pounds of Tiger bone so far that year (Jackson *et al*. 1996). A scathing 1996 report by Dave Currey of the EIA, *The Political Wilderness. India's Tiger Crisis* (Currey 1996), revealed the depth of official indifference to the plight of the Tiger. It documented case after case of failures by the Indian government to preserve the Tiger and its habitat. The most notorious smuggler of Tiger skins and products, as well as other protected wildlife, Sansar Chand, has been arrested many times with smuggled animal skins that total almost 30,000, including Tiger skins, and 30 kilograms of Tiger bones. Each time he has avoided jail by various legal maneuverings and the refusal of the government of Uttar Pradesh in northern India to prosecute him (Currey 1996). The EIA undercover investigation in the State of Madhya Pradesh, where more than a quarter of India's Tigers are found, exposed the illegal offering for sale of the skins and bones of 39 freshly killed Tigers; they were informed that an additional 45 Tiger skins had been poached (Currey 1996). Leopard and Tiger skins were found in stores in all major towns and cities in Madhya Pradesh (Currey 1996).

India's 80 national parks and 441 sanctuaries have the highest designation of protection of all government lands, and they preserve 19 percent of the country's forests (Currey 1996). Yet EIA investigations have revealed an extraordinary deterioration in the quality of protection, with mining, tree-cutting, fishing and other illegal activities permitted in the parks, and underpaid and demoralized staffs. Kaziranga National Park, considered the jewel of the park system, has a highly dedicated staff, according to *The Political Wilderness* report by EIA (Currey 1996), but there are far too few rangers, and they receive very low pay ($68 per month), out of which they must pay for

waterproof clothing and shoes, as well as food for their families. Often they have to go barefoot, and suffer from malaria (Currey 1996). The equipment and facilities are so inferior that the rangers are unable to properly protect the park's 70 Tigers, 1,100 Asian Elephants (*Elephas maximus*), Indian Rhinoceros (*Rhinoceros unicornis*) and Swamp Deer.

To combat this situation, Valmik Thapar and Bittu Sahgal, editor of the wildlife magazine *Sanctuary ASIA*; Belinda Wright, a prominent conservationist; and Tiger biologist Ullas Karanth founded the Wildlife Protection Society of India (WPSI) in 1994. Its major purpose was to protect Tigers from poachers and bring smugglers to justice (Matthiessen 1997). Ashok Kumar of TRAFFIC India joined the group in 1996, and this small organization has brought 82 people to court for wildlife violations; unfortunately, all have been set free because of the total failure of the Indian government to enforce its own laws (Matthiessen 1997). The organization has not given up, however, and they have recently seen signs of progress. They and other Tiger defenders believe that "The Tiger is the very soul of India" (Matthiessen 1997).

In Nepal, a $650,000 U.S. government grant coordinated by U.S.-based conservation organizations will promote eco-development near Royal Chitwan National Park (Jackson *et al*. 1996). This park was once an important Tiger sanctuary, but it lost 25 Tigers to poachers between 1988 and 1990 alone (Ward and Ward 1993). In the 1990s, poaching has continued, and in spite of intensified anti-poaching patrols, nine seizures of Tiger parts--most of them complete skeletons--took place in 1995 alone in villages adjoining two protected areas, and 23 poachers were arrested (Jackson *et al*. 1996). Those Tigers that survive in Nepal remain in Royal Chitwan and Royal Bardia National Parks, and Royal Sukhla Phanta and Parsa Wildlife Reserves, which border on northern India. Tiger populations in 1993 were estimated at about 250, but no recent surveys have been carried out for the country. A program of paying rewards for information leading to Tiger smugglers has led to many arrests in the vicinity of Royal Chitwan National Park (Jackson *et al*. 1996).

Siberian Tigers have been pursued by hunters in snowmobiles, all-terrain vehicles, on horseback and with dogs, but most are caught in steel jaw leghold traps or wire snares. Some hunters are equipped with automatic weapons and night-vision devices (Specter 1995). U.S. researchers were offered Tiger body parts for sale at airports in 1995. Those who are caught poaching or selling illegally taken animals receive minimal penalties--119 people were arrested in the first nine months of 1995 in Primorsky, and none received jail sentences; fines were minimal (Specter 1995). Rangers in the reserves have few vehicles and are not permitted to carry weapons to protect themselves; in 1994, the leader of the Tiger task force was hospitalized when a poacher ran him down with a truck (Specter 1995). In one area near Lake Khanka near China, all 10 resident Tigers were killed between 1992 and 1995 (Specter 1995). Chinese poachers have entered Russia to kill Tigers, and the Russian Mafia is marketing Tiger skins and bones in China in an underground organized crime network (Specter 1995).

Linden participated in a 1995 undercover operation organized by Steve Galster. Posing as American businessmen, Linden, Galster, *Time* photographer Anthony Suau, and Russian environmentalist Sergei Shaitarov were approached by a poacher offering the bones and skin of a year-old Tiger for $11,000 (Linden and Yar 1995). They met the poacher in Krasny Yar, homeland of the Udege people who have fought lumbering and Tiger poaching, and were told by the poacher that killing the Tiger was a bad thing for the Udege, but that it was okay for him to sell the skin because he had not killed the animal. "They all say that," Galster said later (Linden and Yar 1995). After photographing the poacher posing proudly with the Tiger skin, they told him that his price was too high, and informed a local biologist of the poacher's activities. They learned that this was not the poacher's first crime (Linden and Yar 1995). The Bikin Valley, where the Udege live, is besieged for Tiger goods by foreign buyers from Korea and China and some fly helicopters or small aircraft across the border to shoot Tigers and Brown Bears (Galster 1996).

Between 1992 and 1993, more than 100 Siberian Tigers were slaughtered (Galster *et al.* 1994), and in 1994, 20 to 30 (Linden 1995). Some suggest that far more--as many as 65 Tigers--were killed in 1994 (Specter 1995). In view of the enormous land area to be patrolled and the relatively small force of rangers, the actual number of Tigers killed may never be known. Numerous poachers were arrested in 1995, but local authorities failed to prosecute, as a result

of government corruption.

To counter this devastating slaughter, anti-poaching brigades were organized by various conservation groups. The U.S.-based Global Survival Network has funded patrols that have been in the field since January 1994 (Galster and Eliot 1999). The Russian Ministry of Environment launched fiOperation Ambafl with the ceremonial burning of confiscated Tiger bones and skins in Turrisk. It is a specialized, well-equipped brigade that patrols rivers and reserves in Primorski Territory, where 85 percent of Tigers remain (Galster 1996). Some 25 to 30 employees, showing courage and competence, slowed the rate of poaching from 60 or more Tigers a year to 10 to 15 (Galster 1996). The Russian government issued a decree in August 1995 calling for a national strategy to protect Tigers and their habitat and to order all government agencies to cooperate on saving the Tiger. By 1997, $750,000 had been spent on anti-poaching patrols, and this special force has new uniforms, modern weapons and vehicles. Intensive work on the part of the joint U.S.-Russian team in early 1997 uncovered a major Tiger skin trading route and a sea route from Vladivostok to South Korea (Galster and Eliot 1999). Inspections of vehicles, hunters and potential poachers have turned the tide for the Siberian Tiger, aided by outside funding and public relations films, television shows and the help of non-governmental organizations (Galster and Eliot 1999).

In both China and Taiwan, facilities house captive Tigers for the express purpose of killing them for the Traditional Medicine trade. Caged Tigers on truck beds were paraded through the streets of Taipei, Taiwan, in 1986, with loud speakers blaring the date, time and location of the big cats' impending slaughter; their bodies were publicly auctioned (Highley and Highley 1994). Taiwan reportedly had more than 100 Tigers on farms in 1994, 60 more were kept in similar facilities in mainland China (Song and Lu 1994), and another 35 in Thailand. Humane organizations have inspected and filmed these facilities and found animals being kept in filthy conditions, and even starved to death.

China has attempted--unsuccessfully--to obtain permission from CITES members to sell body parts from these Tigers in international commerce.
Two representatives of the Chinese government, Wang Song and Houji Lu (1994), made such an appeal in an official magazine of the CITES Secretariat, *CITES/C&M*. They claimed that the Felids Breeding Centre in Heilongjiang Province had bred 73 Tigers, and now has financial difficulties which would be relieved if they could sell Tiger products from animals that "die from natural causes" (Song and Lu 1994). They both admit that the two subspecies kept there, the Siberian and South Chinese, have been interbred and suffer from various effects of inbreeding (Song and Lu 1994).

In Thailand, Tiger farms have received government approval but are provoking a bitter controversy. In late 1994 one Thai farm had 35 Tigers, and the owner bragged that a dead Tiger fetches up to $10,000 on the black market (AP 1994). He showed a display case with a male Tiger™s dried sex organs that sell for $4,500. Dr. Parntep Ratanakorn, an advisor to the Thai Royal Forestry Department which licenses Tiger farms, believes that Tigers could be farmed as easily as pigs. "The West is too sentimental about animals," he said. "Western people must open their minds and accept the ideas of Asian people because this is mainly an Asian issue" (AP 1994). Maitre Temsiripong, a former pig farmer, runs a farm with two pairs of Tigers that have produced 20 cubs in three years. The Royal Forestry Department's Khao Pardap Chang Captive Breeding Center has bred cubs from a female Tigress mated with her brother. The cubs show signs of inbreeding; they have skeletal abnormalities and cerebral defects, as documented by the U.K. Tiger Trust. A cub photographed by Tiger Trust at the Kaho Pardap Chang facility has a haunted and crazed expression known as "star-gazing," a classic symptom of inbreeding (Tiger Trust 1994).

Cubs in these farms are removed from the mother at birth so that she will immediately mate again, and cages have been constructed at the Thai government's Khao Pardap Chang facility to house many more of these pathetic animals (Tiger Trust 1994). In a change of position, the Thai government stopped granting permission to the farm to kill any of its Tigers beginning in January 1996. Valmik Thapar, at a 1996 Tiger conference, expressed vehement opposition to Tiger farms, urging that they be banned. He stated that such legitimization of the sale of Tiger parts, far from relieving pressure on wild Tigers as its proponents claim, will actually put a bounty onto the heads of the last remaining wild Tigers by legalizing trade. These farms present a major threat to remaining wild Tigers as well as

extreme cruelty to these magnificent animals. International sanctions should force their closure. In the words of Tiger Trust (1994), if present plans are carried out in Thailand, cages will "soon be full of the mournful cries of wailing Tiger cubs awaiting their final and undignified journey to the slaughterhouse."

Maimed Tigers are used as tourist attractions in Thailand. Samutprakan Crocodile Farm outside Bangkok, Thailand, was visited by John Nichol (1987), author of *The Animal Smugglers*. Nichol described a captive Tiger at the farm: "He looked magnificent, lying in a sort of summerhousefl; a chain led from his collar to the wall. Nichol expressed concern that this restraint was inadequate, but he was told, "Tiger very tame," and they encouraged him to take a photo of the animal as it lay on a bed of straw (Nichol 1987). When he approached the Tiger, he saw why they called him "tamefl; his feet were simply floppy stumps half hidden by the straw. He could not even stand. "I should have taken a photograph, but I felt too sick and felt I had to at least make a show of not encouraging the practice. Poor tiger . . ." (Nichol 1987). What had happened to this Tiger will never be known. Perhaps he was captured by both feet with wire snares or leghold traps, and wounds became septic, necessitating amputation. He may have had bones surgically removed for use in Traditional Medicine. Either way, his fate could not have been crueler.

China, a CITES member, legally banned exports of Tiger products in December 1992 (TRAFFIC 1995) but has turned a blind eye to this trade. South Korea obtained two-thirds of its imported Tiger bones from Indonesia (Jackson *et al*. 1996). The Republic of Korea finally prohibited the sale of Tiger products in 1994, and Singapore also banned sale. Japan has not prohibited internal trade in Tiger parts and derivatives (Jackson *et al*. 1996). Chinese Customs statistics show that more than 71,000 kilograms of Tiger bone medicines were exported between 1990 and 1992 to Japan, making it the largest importer in the world (TRAFFIC 1995). Investigators in 1994 and 1995 found wine and pills labeled as containing Tiger bone in Japanese stores (TRAFFIC 1995).

Chinatowns in North America and Europe have provided additional illegal markets for Tiger products. Some products labeled as Tiger bone in these stores were sent to the U.S. Fish and Wildlife Service Forensics Laboratory for analysis and found to be other material. Some real Tiger bone is being imported, however. A Chinese businessman was caught smuggling a Tiger skeleton worth up to $50,000 into the United States in the early 1990s. In the United Kingdom, 28 Oriental pharmacies were visited in August 1994 by TRAFFIC investigators and, in cooperation with police and the Department of the Environment, they confiscated quantities of Tiger bone, rhino horn and bear bile from 14 stores. An investigation in Antwerp, Belgium, uncovered even more such items (TRAFFIC 1995). In 1992, China exported 250,000 pills and five containers of Traditional Medicine containing Tiger to Belgium; its world exports totaled 27 million items in the form of pills and other products from 1990 to 1992 (TRAFFIC 1995).

An upwelling of public concern in the United States and other countries about the impending extinction of the Tiger has inspired many efforts to preserve remaining wild populations. In the U.S. Congress, legislation enacted in September 1994, the Rhinoceros and Tiger Conservation Act, created a fund of appropriations of up to $10 million per year until the year 2000 to be used for conservation programs and projects to enhance enforcement of existing legislation throughout the Tiger's range. The bill also required the Department of the Interior to identify which countries engage in activities that abuse international accords protecting Tigers and rhinoceros. In 1998, the Conservation Act was amended by adding a prohibition on fithe sale, importation, and exportation of products intended for human consumption or application containing, or labeled or advertised as containing, any substances derived from any species of rhinoceros or tiger.fl

In October 1995, a meeting between conservationists, Traditional Medicine practitioners, and traders in Tiger products was organized by TRAFFIC East Asia. The participants came from China, Hong Kong, Japan, Singapore and South Korea. Cooperation between these users and conservationists was the objective (Jackson *et al*. 1996). Its major goal was to convince practitioners to educate consumers to use substitutes for Tiger products.

There are about 1,000 Tigers in zoos, of which at least 360 are Siberian. Captive-bred animals have little chance of surviving if released to the wild, however, lacking survival knowledge which is passed on from generation to generation. Still, one day, they may be the only Tigers left in the world and will have to be used in reintroductions.

Peter Matthiessen, in his 1997 article in *Audubon* magazine entitled fiThe Last Wild Tigers,fl imagined a ". . . future in which the mysteries of wild tigers will be gone and the only tigers left on earth will be these listless specimens cooped up in zoos." The spine-tingling roars that once echoed for miles in tropical forests are fading, and epitaphs are already being written. A 1993 book by Geoffrey C. and Diane Raines Ward, *Tiger-Wallahs*, was subtitled, *Encounters with the Men who Tried to Save the Greatest of the Great Cats*.

The traditional lore upon which the trade in Tiger products is based can be traced to ancient veneration of this animal and the belief that it was capable of warding off evil; children in China wear caps with Tiger designs for luck and protection. Every 12 years, the Chinese celebrate the Year of Tiger, symbol of strength and good fortune, the source of which they are in the process of destroying.

The potential market of Asian consumers of Tiger products is approximately 2 billion people, and ancient traditions resist the reasonable approach of modern medicine and conservation concerns. In order to prevent the extinction of the last wild Tigers, much needs to be done in a very short time. Education must change traditional views to convince consumers to buy substitutes, anti-poaching patrols must be set up throughout their range, and enforcement of trade bans must be strong. Conservationists are working to achieve these goals with the hope that at least some wild Tigers will survive, but a lack of strong commitment on the part of the key governments involved, and the enormous market of uncaring or uneducated consumers, may doom their efforts.

Traditional Medicine Trade: Rhinoceros

All five species of rhinoceros are highly endangered, and within the past decade, illegal trade has pushed them to the brink of extinction. These ponderous, primitive mammals have survived on earth for millions of years. During the Pleistocene period, more than 10,000 years ago, species of rhinoceros now extinct lived in what is now Europe and North America. Today, three species occur in Asia, from India east to Sumatra, and two in Africa south of the Sahara. The White Rhinoceros (*Ceratotherium simum*) of Africa is the largest of the rhinos, with males weighing up to 8,000 pounds (Nowak 1999).

Within the past 25 years, at least 60,000 of the world's rhinoceros have been illegally slaughtered for the Asian trade (Ricciuti 1993). Their numbers have been reduced by more than 90 percent since 1970, and today the combined total of the five species does not exceed 12,000 animals (Kelso 1995). Their horns, which grow vertically atop their heads, have been their undoing. In great demand in the Traditional Medicine trade, and as carved ornaments on dagger handles in the Mideast, these animals have been pursued by poachers into national parks and even zoos. Some rhinos in Africa are guarded 24 hours a day against poachers. In Asia, they are disappearing even more quickly than in Africa because there are too few rangers to protect them, and the price of their horn is higher than for African rhino horn.

Rhinoceros horn is not actual bony tissue, but compressed, fibrous keratin, the material of hair and nails (Nowak 1999). It is ground into powder that has been a traditional medicine for hundreds of years in China and southeast Asia, used for various purposes, such as treating fevers. Asian rhinos vary in terms of horn size, two species having only one horn and the other two-horned species have horns that are often mere knobby bumps. African rhinos have two horns, in general longer than the Asian species, the front far longer than the rear horn, with a record length of 4.8 feet (Stuart and Stuart 1996).

With the invention of powerful guns in the 19th century that could penetrate rhinoceros™ thick hides, they began a long decline. At first, the hunting was primarily for trophies, but also for their horns. Heavy hunting in India by maharajahs and Europeans in the 19th century, and elsewhere in Asia for sport, devastated rhino populations. By the beginning of the 20th century, all three Asian rhinoceros species were near extinction (Nowak 1999). India, followed

by many Asian countries, extended protection to the remaining populations and established national parks and reserves in the first decades of the 20th century.

The Great Indian Rhinoceros (*Rhinoceros unicornis*) was once found throughout the Indian subcontinent, including Nepal and Pakistan east to Bangladesh and Assam (Nowak 1991). As early as 1600, hunting caused these rhinos to begin disappearing from northwestern India and Pakistan, and they continued to decline over the next three centuries (Nowak 1991). By the first decade of the 20th century, they were nearly extinct. In Kaziranga, only 12 Great Indian Rhinos remained; and in Nepal, perhaps another 50. The Indian government banned hunting and bounties and established reserves (Nowak 1999). Rhino numbers rose until the 1980s and 1990s when poaching decimated them again. Nepal now has an estimated 460 of these rhinos, protected by nearly 1,000 armed troops and rangers, while Kaziranga National Park in eastern India has about 1,200. With scattered numbers elsewhere, the species totals about 2,000, with 134 in captivity (Nowak 1999).

Even in parks, poaching occurred in the 1980s and 1990s. Gangs in Kaziranga National Park, the stronghold of this species, cut high tension lines, letting them drop to a height of 2 to 3 feet above rhino paths, electrocuting the hapless animals when they encountered the wires (Speart 1994). Between 1979 and 1989, 500 Indian Rhinos were poached, and this continued in the 1990s, with 48 killed in 1992, and 46 in 1993 (Speart 1994). Since 1992, 123 Indian Rhinos have been poached in Kaziranga, and the species has been completely exterminated in Laokhawa Wildlife Sanctuary where, 13 years ago, 5 percent of its population survived (Currey 1996). In 1993, a Bhutanese princess attempted to smuggle 22 Indian rhino horns into Taiwan to raise cash for a bottling company she owns. Her factory is located near Manas National Park, northern India, where it is thought the rhinos were poached (Speart 1994). The horn was intercepted and confiscated, and legal actions were taken against the princess. An investigation into the smuggling of rhino horn and other wildlife products in the Himalayas found that poachers are exploiting civil conflicts in nations in the region, and they trade rhino horn and other endangered species items in exchange for drugs or Chinese arms which are used to supply the Burmese military (Currey 1996).

The Sumatran Rhinoceros (*Dicerorhinus sumatrensis*) is the most primitive and smallest of all the rhinoceros. This rhino is only 4 feet tall at the shoulder and weighs 2,200 pounds, compared with the 6-foot-tall, 8,000-pound African White Rhino (Line 1997). Although they have two horns, the upper one is usually a mere bump, and the lower one closest to the muzzle is less than a foot long, far smaller than horns of other rhinos. Sumatran Rhino calves are born with a long, dense coat of hair that becomes sparse and bristly as the animals age. The hairs scrape off from abrasion as these bulky animals move through forest undergrowth; captive animals are often very hairy (Line 1997). Different genetically and physically from other Asian rhinos (Rabinowitz 1994), Sumatran Rhinos have three populations, one of which, the Bornean, has been isolated from the others for many thousands of years, and is considered a separate subspecies. Only about 70 Bornean rhinos survive in Sabah province at the northern tip of the island (Line 1997). The majority are in Peninsular Malaysia, where there are between 85 and 126, and on Sumatra, with an estimated 233 to 241. Thailand has only an estimated 10 rhinos (Nowak 1999). Thus, the total population is only about 400 to 541 animals. Some zoologists believe that a few may survive in Myanmar as well (Rabinowitz 1994). The habitat of the Sumatran Rhino is a prehistoric setting of swampy tropical forests with dense vegetation and hilly country near water.

Originally, Sumatran Rhinos ranged from eastern India's Assam province and southeastern Bangladesh to the Malay Peninsula, and possibly Vietnam, south to Sumatra and Borneo (Nowak 1999). Centuries of hunting for their horns for the Traditional Medicine trade eliminated these rhinos in one country and region after another. Surviving Sumatran Rhinos inhabit only remote forests, primarily in national parks, and their populations are scattered. Because of the difficulty of studying them in the wild, their behavior and ecology remain a mystery. A few are now being radio-tracked by biologists, and in the future, more will be uncovered about these unique animals. The International Rhino Foundation (IRF) and the Asian Rhino Specialist Group of the World Conservation Union have proposed projects to save the species from extinction. Poaching is a major threat throughout its range, with local peoples entering reserves and national parks because the horn is so valuable that it represents many years' income.

The Javan Rhinoceros (*Rhinoceros sondaicus*) is the most endangered of the rhinos, with a population which may

total only about 58 to 72 animals (Line 1997). The majority of their population, about 50 to 60 animals, live in Udjung Kulon National Park on the western tip of Java, and an additional eight to 12 live in Vietnam (Nowak 1999). Almost as tall as the Greater Indian Rhinoceros, but less massive at 3,300 to 4,400 pounds, the Javan Rhino has a single short horn, and females often lack a horn or have only a small bump (Nowak 1999). This animal once occurred from eastern India to Vietnam and south to the Malay Peninsula, Sumatra and western Java in three distinct subspecies (Nowak 1999). Habitat loss and persistent killing drove them out of almost all their original range, and one subspecies of eastern India, Bangladesh, Assam and Burma is extinct (Nowak 1999). Poaching continues, and in November 1988, a Javan Rhino was killed 130 kilometers northeast of Saigon, Vietnam (Nowak 1991). There are no Javan Rhinoceros in captivity, and this species has been called the most endangered mammal in the world (Nowak 1999).

Asian rhino horn sells for $27,000 per pound, and most pharmacies in Taiwan and other parts of Asia sell this horn (Rabinowitz 1994; Line 1997). So far, captive-breeding programs have failed, and 21 Sumatran Rhinos have died during capture or in captivity, leaving only 18 in zoos in the United States, United Kingdom, Peninsular Malaysia, Sabah and India (Line 1997). A major controversy has arisen about further captures. A Sumatran Rhino Trust was set up in 1985 to coordinate conservation of wild rhinos and those in zoos, but after eight years, during which time $3 million was spent, it was disbanded in 1993. The program had been undermined by politics, greed and corruption, according to the Wildlife Conservation Society (Rabinowitz 1994).

During the 19th century, African rhinos were heavily hunted for sport, as well as for their hides and horns, which were shipped to Asian markets. In recent times, the Black Rhonoceros (*Diceros bicornis*) ranged from Subsaharan Chad and Sudan south to the tip of the continent (Nowak 1999). By 1900, it had been eliminated from West Africa, but its populations below the Sahara may have totaled 100,000 (Cunningham and Berger 1997). Both the White and Black Rhinoceros occupy different habitats in Africa, based on their diet. The White Rhinoceros is a grazer, cropping grasses at ground level with its square lips, while the Black Rhinoceros is a browser, feeding on brush and low tree branches with its almost prehensile lips. Both are steel gray, despite their common names. During the first decades of the century, East African colonial governments persecuted rhinos on the grounds that their presence was incompatible with human settlement (Nowak 1999). When Asian rhinos became scarce, sport and market hunters turned to the African species and named them as one of the fibig fivefl game animals of Africa, attracting hunters from around the world. Market hunting for Traditional Medicine became an increasingly important factor in reducing African rhinos in the 1970s and 1980s. China and other countries in East Asia grew wealthy, and customers were able to pay high prices for rhino horn. Of all rhinoceros, the Black Rhinoceros declined the most dramatically in the 20th century. From 100,000 in 1900, its population fell to 15,000 in 1980, to only about 2,400 at present (Nowak 1999). Even in national parks where they were heavily protected, these rhinos were gunned down by gangs using machine guns, or strafed and allowed to die slowly of their wounds. Many orphan Black Rhinos were cared for by centers in Zimbabwe and Kenya, but most were killed by predators or died from other causes. At Daphne Sheldrick™s animal orphanage in Kenya, tiny rhinos are tended around the clock, and play chase games with one another or with baby elephants. Contrary to the image that big game hunters disseminated about rhinos being fierce, dangerous animals likely to charge people to gore them to death, they are gentle and near-sighted and lack binocular vision. They are often unable to make out animals or vehicles approaching them and will charge only when they feel threatened or, in the case of females, if their calf is being stalked by predators.

The White Rhinoceros is only somewhat more numerous than the Black, totaling 7,533 in 1996, with the majority in South Africa. It, too, has been eliminated in most of its original range, and killed on sight in and out of national parks.

While some species of rhinoceros have bred in captivity, others, like the Sumatran, have not, and many animals have died while being captured or after short periods in captivity. A few herds of Black Rhinos have been established in semi-wild conditions in Texas and Australia, although for several of these, the purpose may be less to preserve them than to raise animals for trophy hunters to pay high sums to kill. Several captive herds of Black Rhinoceros in Zimbabwe are at extreme risk of being slaughtered as a result of political chaos in which government land seizures for

distribution to black farmers and uncontrolled snaring and hunting of wildlife has already killed many rhinos (Roberts 2001).

In Asia, rhino horn sells for an average of $15,000 per kilogram, with higher prices paid for horn of Asian species. By 1996, black market values ranged from $46,000 to $150,000 per horn. The penis sells for $600 or more and is used as an aphrodisiac. The skin is also valuable, worth at least $7,000 per animal, for use in Traditional Medicine (IUCN 1994). Another threat that has caused the deaths of thousands of rhinos is their use in dagger handles in North Yemen. The rhino horn is carved into intricate designs for these daggers, which sell for $300 to $13,000 each (Fitzgerald 1989). From 1982 to 1984, about 3,700 pounds of horn entered North Yemen every year (Fitzgerald 1989). Taiwan's 22 million people use about 700 pounds of horn a year, or 80 rhinos.

Prior to the major killing spree that began in the early 1980s, CITES members voted to list one rhino species after another on Appendix I, banning commercial trade in their horns and bodies, whether for Traditional Medicine or trophies. By February 1977, the entire family Rhinocerotidae had been listed. Conservationists believed that this would stop the slaughter. Thousands of rhinos remained in national parks in Asia and Africa, and national legislation in many countries of origin banned hunting. Tragically, illegal trade nullified all legal prohibitions except in South Africa, where White Rhinos were effectively protected, and increased during the 1980s. For the rest of the world's rhinos, an all-out slaughter occurred. Organized gangs of poachers, some armed with machine guns, eluded the less well-armed rangers. They entered African national parks and strafed the helpless rhinos, cutting off their horns and leaving their maimed bodies to rot in the sun. In Asia, these enormous animals made easy targets for poachers, and many were poisoned, snared or fell into spiked pit traps.

One smuggling ring was broken up in 1993 by undercover work by Steve Galster, Executive Director of the Global Survival Network, and Rebecca Chen, a Taiwanese colleague. The two tracked shipments of rhino horn from Mozambique to Taiwan to Hong Kong, and finally to China, where they found a warehouse in Wuchuan housing the horns of more than 500 dead rhinos, a supply worth $13 million (Linden and Yar 1995). They fabricated a reason to see the horn and produced a videotape that jailed guilty parties and called international attention to the smuggling (Linden and Yar 1995).

The United States banned all wildlife products from Taiwan in 1993 when it was revealed that open sale of Tiger parts and rhino horn was occurring. This embargo was lifted in less than a year when Taiwan showed evidence of controlling its illegal wildlife trade. Taiwan's new Wildlife Conservation Law brought about a registration of all privately held rhino products in late 1994; a total of more than 457 kilograms of whole rhino horns, taken from 153 animals, horn pieces and powder was registered (TRAFFIC 1995). These items are identified and photographed along with Tiger products but, unfortunately, allowed to remain in private hands.

In the past, confiscated rhino horns in Africa have been destroyed to keep them from entering commerce. A CITES resolution in 1994 changed this recommended procedure. Significantly, it urges Party countries with rhino horn to identify, mark, register and secure these stocks (Kelso 1995). This overturns the recommendation made in 1987 for these stocks to be destroyed, which was repealed. The current Resolution (Conf. 9.14) notes that Parties view destruction as being "no longer appropriate" because it may cause prices to escalate and lead to new poaching for rhino horn to replace the destroyed stock (Kelso 1995). Since stocks of seized rhino horn kept by various countries are, by definition, not available in any way to traders unless they are stolen or somehow given out, this appears to be the first step toward releasing these stocks for trade, and to allow trade in horns sawed off living rhinoceros.

Many conservationists believe that traders have built up private stockpiles of rhino horn for possible future sales (Ricciuti 1993), and some government stocks, such as China's, are considerable. An estimated 1.1 million pounds of horn from slaughtered rhinos are thought to be stockpiled in Taiwan and China. Other parts of the 1994 CITES Resolution were more laudable: it urged stricter domestic legislation to reduce illegal trade, and the education of Traditional Medicine sellers and users to eliminate consumption (Kelso 1995). South Africa had attempted at the 1994 CITES meeting to remove the South African population of the Southern White Rhinoceros from Appendix I, which bans commercial trade, and downlist it to Appendix II to open up trade. This proposal was not accepted, but

CITES Parties voted to allow sale of live animals and trophy hunts until the following meeting. The government of South Africa reproposed downlisting to Appendix II at the 1997 CITES Conference, again unsuccessfully, offering to submit annual quotas to CITES for approval and to use stockpiled horn and horn from natural mortalities, calculated at 230 per year. This would be augmented by horn obtained from dehorning of animals in the private sector (Hughes and Brooks 1996). Zimbabwe hopes to legalize trade in rhino horns, with state farms where herds of rhinos would have their horns cut off to supply the Chinese medicinal trade (Keller 1994). Both Zimbabwe and South Africa have enormous stockpiles of rhino horn obtained from poachers and dehorning programs that would be worth millions if the ban on international trade was lifted (Keller 1994).

Legalizing trade in rhino horn would prove disastrous for the species, just as the trade in ivory nearly caused the extinction of both species of elephants. The horns of Southern White Rhinos are not distinguishable from other rhino horn, except perhaps through forensic methods not available to import and export personnel. Even the live animals are difficult to distinguish by race (Hughes and Brooks 1997). The market for this horn far exceeds the supply and would not be appeased by the few hundred horns that enter trade each year from South Africa. Poaching would accelerate, and horns from illegally killed animals would not be distinguishable from those that had been stockpiled. This would further endanger the remaining wild populations of rhinos around the world, since their horns might be represented as legally obtained. In view of the enormous revenues that South Africa accrues from tourism--$6 billion in 1995 by its own accounting (Hughes and Brooks 1997)--the funds from sale of rhino horn can only be considered of minor importance. Efforts should be made to funnel ecotourism funds to rhino conservation, since that is one of the arguments being used to justify reopening the trade.

Dehorning of rhinos with the declared objective of making the animals unattractive to poachers has been carried out in Zimbabwe and Namibia. They are darted with tranquilizer guns, and the horn is sawed off the unconscious animal. The horn grows back in about one year, and the process must be repeated. Preliminary evidence in countries conducting dehorning indicates that rhinos continue to be poached, apparently just for the stump or, perhaps, because the poachers were unable to see whether the animal had its horn (Keller 1994). Even more importantly, females that have been dehorned have, without exception, lost their calves to predators (Speart 1994). Rhinos use their horns in territorial displays, mating, and defense and, it has now been established, to defend their calves from hyenas, Lions and other predators. Moreover, this procedure is expensive and involves trauma and possible death to rhinos.

Zimbabwe, a country that prides itself on its "sustained yield" approach to wildlife, has an entirely different approach to protecting rhinos than East Africa and most other African nations. The government launched fiOperation Strongholdfl in 1984 to prevent poaching, with highly armed rangers trained to kill poachers, and a goal of preserving its once large rhino populations. Once a stronghold for the Black Rhinoceros, with a population of at least 1,400, the country's rhinos declined to 400 by 1992, and to 300 by 1994 (Speart 1994). Only 200 White Rhinos remain in Zimbabwe, and their numbers are also in decline (Stuart and Stuart 1996). Anti-poaching efforts failed to stop the killing of 954 rhinos between 1984 and 1991; during that period 145 poachers and four conservation officers were shot (Stuart and Stuart 1996).

The market in rhino horn has been extremely difficult to control, since the horn can be reduced to a powder that is easily smuggled, sold surreptitiously, or in some countries openly, in a vast network of apothecary shops in Asia and Chinatowns throughout the world. With fewer than 12,000 rhinos remaining alive and a potential market of millions of Asians, the future of these ancient animals is bleak. Throughout the millions of years that rhinoceros have existed, their armored hide and horns have helped them defend themselves against a wide variety of predators, but against a legion of new weapons and cold-blooded greed, they may not survive much longer.

Traditional Medicine Trade: Bears

Bears of all species have come under siege from a variety of causes, including habitat loss, hunting, killing for meat and as "nuisances." Their greatest threat today, however, is their slaughter for the market in bear products, mainly their gallbladders and paws. All of the world's eight species of bears, except the Giant Panda, have suffered population declines as a result of this Traditional Medicine trade (Knights 1996). Their gallbladders are ground into powder, and bile is extracted for various medicinal purposes, including digestive problems, inflammation and blood purification. Sold at extremely high prices, a record $45,000 was paid for a single gallbladder (Barron 1991). To illustrate the avid market in this product, an Asian dealer in New York City was murdered in 1991 to obtain his profits from the sale of bear gallbladders. Japan imported 1,500 pounds of bear bile in 1989 alone (Schaller 1993).

The largest consumer of bear bile is now South Korea, and Koreans have even hunted Black Bears (*Ursus americanus*) in California and placed ads in newspapers to purchase bear gallbladders from hunters (Knights 1996). A Grizzly or Brown Bear (*Ursus arctos*) gallbladder can sell for up to $10,000 on the black market, and the larger the gallbladder, the higher the price. A Black Bear gallbladder can be purchased from a poacher in Idaho for $15, but in Hawaii, it brings $1,500, and in Korea, as much as $15,000 (Barron 1991). Some AIDS patients in the United States take extracts of bear gallbladder as a supposed cure for this disease, according to CBS News (July 7, 1993).

The Asiatic Black Bear (*Ursus thibetanus*), already endangered and listed on Appendix I of CITES before the 1980s, may now be verging on extinction, according to the Chairman of the IUCN Bear Specialist Group (Servheen 1989). Native to most of Asia from Iran and India east to Mongolia, Russia and Vietnam, this species has been the major target of the gallbladder trade. From 1979 to 1988, up to 59,000 gallbladders were illegally exported from China to Japan (Servheen 1989). A wild Korean Black Bear shot in 1982 was sold at auction for $18,500 (Servheen 1989). Fewer than 10 of these bears remain in Korea, according to the Korean Federation for Environmental Movement after they were finally given protection. In 1996, five Koreans and two Thais were arrested in South Korea after they were caught with the carcasses of six wild bears with the paws chopped off and internal organs extracted (WuDunn 1997). Hunters of these bears will often frighten or wound the bear first in order to let it die slowly, in pain, in the belief that the gallbladder becomes larger when the animal suffers (WuDunn 1997). South Korea recently banned sale of bear parts except for U.S. bears, which are still allowed to be sold. The bear bile is touted as a magical cure-all, used in health tonics and aphrodisiacs throughout Korea (WuDunn 1997). An average of more than 2,000 Asiatic Black Bears per year are killed in Japan, and many are exported as live animals or parts, primarily to Korea.

The World Society for the Protection of Animals (WSPA) reported in 1995 in *The Protector* that an illegal shipment of 21 live small bear cubs, of which 20 were Asiatic and one was a Sun Bear, was seized in Thailand. All had been captured in Burma, and the smuggler had made an arrangement with airport authorities in Thailand to let these Appendix I species pass on their journey to Korea to be killed and their paws removed for restaurant diners. The Thai forestry department was informed and confiscated the bear cubs. After the seizure, three died of disease, brought on by their crowded and unhealthy captive conditions. These cubs, which would still have been with their mothers, were placed by the World Society for the Protection of Animals in a humane rescue center. This species has declined so dramatically throughout its range that the Traditional Medicine trade has turned to other bear species. The Asiatic Black Bear ranges into Siberia, where it is being slaughtered for its gallbladder in spite of being legally protected (Galster 1996). The IUCN Bear Specialist Group's Chairman, Christopher Servheen, in his report *The Status and Conservation of the Bears of the World* (1989), predicted that without strict controls on trade and hunting, the Asiatic Black Bear could become extinct throughout most of its range in the very near future.

An estimated 8,000 to 9,000 Brown Bear gallbladders are exported from Russia annually, of which half are legally hunted bears and half are poached animals, but no official records are being kept (Knights 1996). The Brown Bear is the national symbol of Russia, and yet the combined effects of disintegrating law enforcement, financial gain from selling bear body parts, and official corruption pose serious threats. Russian poachers receive about $200 per gallbladder, and they are sold in Korea for up to $5,000 apiece (Galster 1996). In 1995, in the Bikin Valley of Russia's Far East, bear poaching was reported on the rise, and the Amba patrol protecting Siberian Tigers reported seeing an increasing number of orphaned bear cubs (Galster 1996). Some cubs are killed along with their mothers; a

report by the Investigative Network included a photograph of a dead mother Brown Bear and her slaughtered infant cub, killed for their gallbladders in Russia (Galster 1996).

After floods in northeastern China in mid-1995, many Brown Bears crossed over the Amur River into Russia to reach higher ground, and hunters converged on them (Galster 1996). They were pursued into forests by four-wheel drive vehicles, and at least 60 were shot. Because the trade in bear parts is legal in Russia, little can be done to stop the poaching (Galster 1996).

The grisly consumption of bear paws, which are cooked as a gourmet delicacy that to some is also health promoting, is widespread in Asia. Served at Japanese business banquets, they can cost $1,000 per person; a Seoul restaurant advertised bear paw soup in 1994 at $1,000 per bowl (Knights 1996). More than 900 kilograms of paws were imported annually into Japan from China in the mid-1970s, and about 600 kilograms per year entered in the 1980s (Servheen 1989). In 1987, one Chinese city, Harbin, consumed 4,000 pounds of Brown and Asiatic Black Bear paws, and nine live bears were smuggled into Guangzhou City to lease to restaurants in order to lure customers (Schaller 1993). In 1990 a single load of 4,000 kilograms of bear paws from 1,000 bears was intercepted at the Chinese border headed for Japanese and Korean buyers (Knights 1996). Live bears, imported with the pretext of going to zoos, are killed in front of Korean restaurant customers (Servheen 1989). A Korean newspaper reported that live bears are lowered onto beds of hot coals, where they are held until their feet are cooked (Knights 1996). In China, servings of bear paws sell for between $346 and $576 each. At the Beijing Lou restaurant, braised bear paws are advertised on a three-sided, revolving, illuminated sign, with enlarged photos of the paws (Highley and Highley 1994).

Sun Bears (*Helarctos malayaunus*), smallest of all bears, are native to southeast Asia. Populations of this species have been severely reduced by the capture of many animals shipped to South Korea for their paws (Highley and Highley 1994). The Sun Bear is an endangered species on Appendix I of CITES, and total populations are thought to be less than 20,000; it ranges from India though Thailand to Sumatra and Borneo (Knights 1996). Another rare Asian species, the Sloth Bear (*Melursus ursinus*) of India, Sri Lanka, Bangladesh, Nepal and Bhutan, is thought to number less than 10,000 (Knights 1996). It is listed on Appendix I of CITES and listed as Vulnerable by the *2000 IUCN Red List of Threatened Species*. An estimated 728 to 1,548 Sloth Bears in India alone are also being killed for the restaurant and gallbladder trades (Nowak 1999; Servheen 1989).

Asians are not the only ones who consume bear paws. An American entertainer, Tommy Tune, joked on a U.S. talk show about a banquet he attended in Japan where he ate a bear's left paw. It had been ordered one week in advance, probably so that a live bear would be killed or maimed for the purpose. Jay Leno, the host of the fiTonightfl show, on which Tune was a guest, said "Imagine a bear getting its paw cut off! How could you eat that?" Tune replied, "Oh, you just don't think about it."

Bear fifarmsfl have been established in several Asian countries, keeping these animals in captivity to extract bile from their gallbladders. China had an astounding 10,000 Asiatic Black Bears in bear farms throughout the country (Knights 1996); but that number has been reduced to fewer than 8,000 at the beginning of the new millenium. They represent at least a third of the species' entire population. An investigation by two researchers (Highley and Highley 1994), who visited a number of these farms and published a report, *Bear Farming & Trade in China and Taiwan*, found bears being kept in extremely cruel conditions in cages only 3 feet by 4 feet by 8 feet, so small they could barely move (Highley and Highley 1994). Some cages are raised off the ground like rabbit cages, and others are placed on the ground, with bears often lying in their own excrement. Films and documentation of the conditions in which these bears are kept have provoked international outcries (Highley and Highley 1994).

The extraction of the bile from caged bears is another cruelty. Christopher Servheen, a bear biologist, witnessed such an operation, in which the owner used a metal pole to harass the small bear, which already had a badly scabbed nose, into a narrow portion of its cage. As his wife distracted the bear with a pan of sweets, a door was lowered and metal rods inserted to confine the bear and keep its legs from interfering with its abdomen. The owner reached in,

unlocked the metal panel, and a plastic bag attached to a catheter dropped down, which was half full of a green-brown liquid. The bear scraped and clawed wildly at the cage when the owner proceeded to extract the liquid from the bag with an oversized hypodermic needle, withdrawing two full syringes (Highley and Highley 1994). Several caged bears with one or more paws cut off for sale to the restaurant trade have been seen on these farms (Highley and Highley 1994).

An organization based in Hong Kong, Animals Asia Foundation, run by Jill Robinson, has begun a rescue operation to save at least 500 Asiatic Black Bears from bear farms. They will live in a sanctuary where they are able to roam free. The organization signed an agreement with the China Wildlife Conservation Association in Beijing and the Sichuan Forestry Department to close the worst bear farms in Sichuan with the goal of expanding the initiative to other provinces and promoting the manufacture and use of synthetic or herbal substitutes for bear bile. Many of the bears rescued had severe wounds from the catheters implanted to drain bile, or from banging their heads against the bars. Their teeth were broken and worn down from biting cage bars in a vain attempt to escape. They are being given veterinary care at the Animals Asia Foundation.*

*Animals Asia Foundation, Hong Kong Headquarters Office, P.O. Box 82, Sai Kung Post Office, Sai Kung, Kowloon, Hong Kong; Web site: www.animalsasia.org. Donations are needed for this important rescue work.

The World Society for the Protection of Animals (WSPA) has been extremely active in rescuing bears from inhumane conditions in Europe and Asia, and its recent research on 44 bear farms was published in two reports in 2000: *The veterinary, behavioural and welfare implications of bear farming in Asia* details the conditions on these farms, in which cages are tiny metal boxes with holes punched for ventilation; the extremely abnormal behavior exhibited, such as self-mutilation; and the untreated wounds, deformities and health problems. *From Cage to Consumer* is a market survey showing that bear gallbladders and bile are being sold in most major U.S. and Canadian cities, with prices of up to $650 for a whole gallbladder. The United States and Canada thus help to keep these cruel farms in business. Legislation to ban U.S. sales failed in recent Congressional sessions, but was reintroduced in 2001.

According to the Association of Chinese Medicine and Philosophy in Hong Kong, there are at least 54 alternatives to bear gall, including common rhubarb and a type of gardenia (Knights 1996). A chemical used in Western medicine to dissolve gallbladder stones, Ursodeoxycholic acid (UDCA), has been synthesized from cattle bile acid for the past 50 years (Knights 1996). Twelve tons of this chemical are produced by a single pharmaceutical company in Korea every year. This product has been approved by the U.S. Food and Drug Administration. Many practitioners of Traditional Medicine are unaware of synthesized UDCA, and most prefer to stock products from rare wild animals (Knights 1996). Korean practitioners claim that only the real bear bile is effective, a totally false assumption but one that keeps the demand strong (WuDunn 1997).

The Traditional Medicine trade in bear products is also practiced in South America, where the endangered Spectacled Bear (*Tremarctos ornatus*) is struggling for survival in its Andean habitat. Bear fat is used for bone bruises and claws for strength and fertility; machismo is associated with killing these bears (Servheen 1989). Total numbers of this rare species are estimated at only 10,000 animals (Knights 1996). Although protected throughout its range, enforcement is poor (Servheen 1989). It is listed on Appendix I of CITES.

The Fish and Wildlife Service's Forensics Laboratory, after intensive research, is now able to identify bear gallbladders by species if a bit of tissue is attached for DNA analysis (Knights 1996). However, law enforcement officers are unable to distinguish by sight alone whether the gallbladders come from an endangered species of bear. Detection of smuggled bear gallbladder in packages and luggage by trained dogs is one step in the right direction. British Columbia has begun training dogs for this purpose, and should this become widespread, confiscations might have a major effect on smuggling.

Traditional Medicine Trade: Sturgeon

Caviar, the eggs of sturgeon of many species and several other species of fish, is considered a great delicacy by gourmet diners around the world. The killing of sturgeon for the most valuable types of caviar has pushed many species of these ancient fish close to extinction. Caviar is the most valuable of all fisheries products. Prime Beluga caviar from Russia sells for as much as $80 per ounce ($1,280 per pound), and Iranian Beluga for $125 an ounce ($2,000 per pound) (Fabricant 2000). Beluga sturgeon (*Huso huso*) breed in the Volga River and spend their lives in the Caspian Sea, which is bordered by Russia, Kazakhstan, Turkmenistan, Azerbaijan and Iran. Two other species native to the Caspian, Russian Sturgeon (*Acipenser gueldenstaedti*) and the Sevruga or Stellate Sturgeon (*Acipenser stellatus*), have also declined to endangered status. Prior to the overfishing, damming of their spawning river and pollution of the Caspian by industry, pesticides and offshore oil rigs, these sturgeon were abundant and reached great lengths and weights (Tyler 2000). A Beluga caught in 1926 was estimated to be 75 years old, weighed 2,000 pounds and yielded 396 pounds of caviar (Sparks 1992). Even larger individuals weighing 2,500 pounds and measuring up to 28 feet in length have been reported (Sparks 1992). As recently as the 1970s, Beluga at least 60 years old were regularly caught (Platt 1995). Today, few giant sturgeon remain anywhere in the world. Ninety percent of Caspian Sea sturgeon are killed before they are mature enough to reproduce; the typical adult is now less than 18 years old and weighs only about 77 pounds (Platt 1995).

Sturgeon of the Caspian Sea produce 95 percent of black caviar, the most sought-after of all caviar. Their decline began with the construction of large dams on the Volga River which disrupted their migration to spawn. Fewer and fewer sturgeon are able to negotiate this river and its tributaries (Stewart 1992). The older females, aged 50 or more, produce great amounts of caviar, at least 3 million eggs, then go back to the Caspian for several years before returning to spawn again (Sparks 1992). Large sturgeon, because of their armor-like skin, become immobile and passive when caught (Stewart 1992). The fish are stunned and transferred to a fish barge in legal fisheries, where they are kept alive until processing. Then the sturgeon is cut open while still alive, and the roe is scooped out and placed in buckets (Stewart 1992).

After the breakup of the Soviet Union in 1991, well-armed poaching groups replaced the strict legal fishery and began netting female Beluga (Stewart 1992). Russian citizens offered small jars of illegal caviar to foreigners at hotels and airports at exorbitant prices (Stewart 1992). As proof of the continued illegal trade, 450 tons of caviar from Russia and Iran were sold by the European caviar trading company Dieckmann & Hansen in 1995, but legal production of caviar was only 225 tons (DeSalle and Birstein 1996). The U.S. Department of Commerce statistics on caviar imports show a recent increase of 100 percent since 1991, according to investigations by two molecular biologists with the American Museum of Natural History in New York, Rob DeSalle and Vadim J. Birstein (1996). In order to determine the species from which various caviars derive, these two scientists did DNA analyses on 25 samples, 23 from gourmet stores in New York City, and two brought from Russia. Many were mislabeled, and several had come from threatened species. One sample of Siberian Sturgeon (*Acipenser baerii*) was labeled as Beluga (DeSalle and Birstein 1996). The quota for the latter species was 200 to 300 tons for all Siberian rivers, but in 1994, in the Ob River alone, the illegal catch was 250 to 300 tons (DeSalle and Birstein 1996).

By 1995, populations of sturgeon in the Caspian Sea reached new lows. In 1996, the *IUCN Red List of Threatened Animals* listed Beluga, Sevruga and Russian sturgeon as Endangered. The vast majority of sturgeon species of Eurasia were also listed, as a result of overfishing. In June 1997, the entire Order of sturgeon, Acipenseriformes, including all species of sturgeon and paddlefish, was listed on CITES Appendix II. Appendix II does not necessarily ban trade, but only requires export permits that certify catch did not deplete wild populations, and it is generally not strictly enforced. Illegal fishing by organized poaching gangs in countries lining the Caspian Sea continued, pushing depleted populations closer to extinction in the following years. It was estimated in 2000 that actual catch totaled 25 tons, 5 to

10 times the official catch (Tyler 2000). Even this was 0.1 percent of the 22,000 tons regularly caught each year in the 1970s (Higgins 2001). In 1999, official U.S. Commerce statistics showed 14 tons of Beluga as imported into the United States, representing the eggs of 1,600 female fish (Revkin 2000). Twice that many Beluga are killed by poachers because of the difficulty in distinguishing between male and female (Tagliabue 2000). In an effort to stop international commerce in Beluga, the most endangered of the Caspian Sea sturgeon, the Natural Resources Defense Council, the Wildlife Conservation Society, and SeaWeb petitioned the U.S. Fish and Wildlife Service in December 2000 to list the species as Endangered under the Endangered Species Act. These organizations established a website, www.caviaremptor.org, urging consumers to stop buying caviar (Revkin 2000).

A scientific report compiled for CITES by TRAFFIC, an organization of the World Conservation Union, was issued in December 2000. It concluded that Beluga and other sturgeon from the Caspian were not being sufficiently protected under the terms of their Appendix II listing (Tyler 2000). Proposals to list Beluga and other critically endangered sturgeon were discussed at a meeting of a CITES Scientific Committee in December 2000. The committee agreed that Beluga and Kaluga (*Huso dauricus*), a sturgeon of the Amur River of eastern Siberia and northeastern China that can weigh up to a ton, merited listing on Appendix I, banning all commercial trade, because of their status (Revkin 2000). However, the committee decided against placing them on Appendix I because the members concluded that the trade ban would cause economic disruption in the impoverished Caspian region and would bankrupt legal traders, importers and hatcheries (Revkin 2000). Instead, it recommended a reduction of 80 percent in fishing quotas. In June 2001, the CITES committee formally rejected Appendix I listings for these sturgeon, giving countries bordering the Caspian until the end of the year to formulate a management plan that would conserve the species (Higgins 2001). The black market in caviar, unaffected by quotas and management systems, was estimated by Russia's Prosecutor General's Office in 1999 at between $2 billion and $4 billion a year (Filipov 2001a). It has not been controlled by any country along the Caspian Sea, with the possible exception of Iran. A Russian program to stop all vehicles on roads bordering the Caspian Sea to check them for illegal caviar has been a failure, as a *Boston Globe* correspondent found when traveling in a sedan with a hidden 70-pound Beluga. The car was waved along by a policeman after he asked if the driver had any fish or a secret compartment but did not search the car (Filipov 2000b).

In June 2001, four former Soviet republics on the Caspian Sea agreed to cooperate to try to stem the precipitous decline in sturgeon by conducting a scientific survey of populations and then setting quotas, along with coordination of anti-poaching campaigns (Higgins 2001). Russia, Azerbaijan and Kazakhstan agreed to stop all fishing for sturgeon for 2001, and Turkmenistan is expected to approve management plans (Tagliabue 2001). This does not stop the international trade, however, either legal or illegal. Most chefs and restaurants in the United States and Europe have failed to boycott Beluga and other endangered caviar. An exception is the famous French chef, Jacques Pepin, who wrote an Op-ed essay for *The New York Times* on July 3, 2001, urging a boycott and stating that the temporary fishing ban in the Caspian was inadequate to protect these sturgeon. He commented: "There are many luxuries in life in which we can still indulge. The beluga sturgeon can't afford for us to indulge in this one" (Pepin 2001).

The snob value of caviar has been promoted for generations, and this, too, encourages overfishing. A lack of conservation among those who buy caviar may push Russian sturgeon past the point of recovery. Sturgeon are not alone in their dramatic declines from overfishing. Orange Roughy, Atlantic Bluefin Tuna, Atlantic Cod and Haddock, Chilean Bass and many species of shark are among other fish pushed toward extinction in the past decade.

Traditional Medicine Trade: Seahorses

Among the most unusual and delicate of marine creatures, seahorses have been admired for centuries by naturalists. They have been harvested since the 14th century Ming Dynasty in China, and their bodies dried and ground to a powder used to cure a variety of ills, including asthma; broken bones; impotence; kidney disorders; heart,

skin and thyroid ailments; and as an aphrodisiac (Vincent 1995). About 35 species of seahorses are found in both tropical and temperate oceans, all of the genus *Hippocampus*. They vary greatly in size and form. The smallest is about 10 millimeters (0.39 inches) long, and the largest, 300 millimeters (11.7 inches); they weigh from about 3 grams up to 25 grams (Vincent 1995). Some seahorses have evolved elaborate lacey fins resembling seaweed, but most have a distinctive armored body with an extended abdomen and long, tapered snout evoking the profile of a horse; their tails wind forward into a spiral. They swim in an erect posture, moving tiny, spineless fins at great speed. Their method of reproduction is highly unusual. The female deposits fertilized eggs in the male's abdominal pouch, and after gestation, he thrusts the young seahorses out of his belly. Seahorses mate for life, and if one of the pair is killed, the remaining one does not readily remate (Vincent 1995). Wherever they occur, seahorses tend to be sparsely distributed in their seagrass, coral and mangrove habitats (Vincent 1995).

A two-year study (1993 to 1995) by biologist Amanda Vincent in Southeast Asia, found an extensive trade in seahorses for Traditional Medicine, aquariums and the curio trade (Vincent 1995). Collectors in the Philippines receive as little as 25 cents, while dried seahorses sell for up to $1,200 per kilogram at retail (Vincent 1995). They are also ground up and sold in pill form, mixed with other ingredients. By 1997, Vincent calculated that the worldwide trade consumes at least 20 million seahorses per year (quoted in fiKingdom of the Seahorsefl film; see Video).

Hong Kong is the center of the trade, and Vincent™s research revealed that traders offered to buy 500 kilograms to a ton a month, far more than the supply of wild seahorses can support. In Hong Kong, seven seahorses sell for $75. They are shipped to China, which provides the largest market, followed by Taiwan, and Singapore. The Chinese market in the United States is also substantial. Some 200,000 dried seahorses were imported from the Philippines in 1987 (Vincent 1995). U.S. fishermen are now a source of seahorses. In the mid-1990s, Florida supplied 100,000 seahorses a year to the market, mainly gleaned from nets set for shrimp. Many of the seahorses caught in shrimp nets are injured, and the shrimp fishermen discard them, sweeping them overboard. A large percentage consist of pregnant males, whose young do not survive, according to Vincent. A single Japanese order for 100 kilograms involved the killing of 28,000 seahorses; Australia imported 140,000 dried animals in May 1995, and another million live ones for the aquarium trade (Vincent 1995).

The major capture method, scooping the seahorses in nets in shallow water, is used throughout Southeast Asia. Vietnam and the Philippines are the largest suppliers (Vincent 1995). Vincent interviewed many fishermen in widely divergent areas from India, where the fishery was state-sponsored, to Java, Bali and the Philippines. In the Philippines, catches are half or one-third what they were in 1993, indicating how fast the decline has taken place (Vincent 1995). With the high price offered, more fishermen are pursuing seahorses, causing declines. Another sign of depletion is the decline in size of seahorses caught, most of which represent immature animals that never bred before capture.

The *IUCN Red List* included more than 30 species in 1996, all as Vulnerable, a sign of the widespread decline of these fish. The majority were native to the Indian and Pacific Oceans, although the Atlantic, Mediterranean and Black Seas also harbored threatened seahorses. Without strong conservation programs, seahorses and their close relatives are likely to disappear from the wild.

Vincent has helped set up programs, in close cooperation with Philippine fishermen, in which sanctuaries are set aside where no fishing is allowed. They are patrolled by boat, and pregnant males are placed in these sanctuaries to have the young. The villagers, at first suspicious of Vincent's motives, have realized that this is the only way to prevent the extinction of the seahorses, and the management program is now being copied in other coastal fishing villages. The villagers, especially the children, are taken to the sanctuary to see these fascinating creatures in the wild, and have a new appreciation for them.

Wild Pets and Laboratory Animals

Wild Pets and Laboratory Animals: Birds
Enormous numbers of wild birds are captured for the cage bird trade. The Environmental Investigation Agency conducted a field research project in Senegal in which they documented the capture of as many as 20 million wild birds, mainly finches. EIA™s films and research of the trapping of wild birds in Senegal and Argentina revealed that 50 percent or more die of shock or injury prior to export. The birds are traumatized by the capture and often injure themselves trying to escape; few receive humane care and proper nutrition. In fact, EIA found birds held prior to shipping to export centers in unsanitary, crowded conditions, and cared for by people with little or inadequate knowledge about their feeding and care, causing considerable mortality in the first days after capture. In Senegal, EIA filmed the transport of thousands of these birds to export centers hundreds of miles away, in the tropical heat, crammed into cages strapped to the tops of the buses. At stops, the dead and dying birds were thrown out along the side of the road.

Wild Pets and Laboratory Animals: Birds: Page 1
Customers in pet stores, seeing docile parrots and chattering finches, rarely realize that these birds are the survivors of a trade that kills as many as 15 million birds per year. In the homes of pet owners, many wild-caught birds, especially large parrots, fail to adjust to captivity and die from a variety of illnesses, from salmonella contracted in quarantine stations to the lethal wasting disease which is untreatable. Since large parrots, such as macaws, cockatoos and Amazon parrots, may live to an advanced age, birds captured for the pet trade may have spent 20 years or more in the wild, in the company of other parrots, flocking, foraging and roosting together 24 hours a day. In recommending against the purchase of macaws, ornithologist Charles Munn (1988) said:. "A long life in a small cage is dismal and cruel compared with life in the wild . . . For such intensely social birds, life alone in a cage must be the ultimate psychological torture." Parrots are long-lived birds, surviving 80 or more years, but in captivity, their lives usually last less than a decade.

Research has revealed that many parrots are highly intelligent. Their brain size is far larger in proportion to their bodies than other birds. One Gray Parrot (*Psittacus erithacus*), Alex, studied for many years by Dr. Irene Pepperberg, has an IQ equivalent to a 3-year-old child, and a vocabulary of more than 100 words that he understands the meaning of; he does not just repeat them. He recognizes more than 30 objects which he can identify by name, and when asked conceptual questions (fiWhich key is green?fl), he is able to select the correct one more than 80 percent of the time. He understands what "round" and other shapes and sizes mean, and can tell what different objects might have in common, such as color (Kaufman 1991). Parrots compare in intelligence with primates, yet most pet parrots are treated like animated tape recorders, taught to repeat phrases. There are different standards for captive birds than for mammals. For example, if we saw a case of a pet deer or antelope hobbling about with its legs tied together to prevent it from running away, we would alert the local humane society and police. Yet bird owners routinely clip the wing feathers of their pets to prevent flight. This results in an equal hindrance of movement and causes the bird anxiety because it cannot fly from a potential threat, yet it is neither illegal nor frowned upon.

Until recently, the United States was the world's largest importer of wild birds, providing an enormous market for exotic finches, parrots, cockatoos, mynahs and other birds. Almost 1 million birds a year were imported during the 1980s. A large percentage of these birds, approximately 80 percent, were wild-caught in the tropical forests and grasslands of Latin America and Asia and the sub-Saharan region of Africa. All parrots (Order Psittaciformes)--except the Budgerigar, Cockatiel and Rose-ringed Parakeet-- were added to Appendix II of CITES in 1981. However, because of failure to enforce the provisions of the treaty, which require that export be allowed only if it does not adversely affect the species, this had little effect on limiting the massive trade. At the height of the 1980s wild bird trade, the Royal Society for the Preservation of Birds estimated that 500,000 wild parrots were being captured per year worldwide.

The U.S. Congress enacted the Wild Bird Conservation Act (WBCA) in 1992, a law that effectively stopped commercial imports of wild parrots and all other birds listed on the Appendices of CITES. It allows zoological imports, non-CITES birds, and some captive-bred birds. The law sharply reduced the importation of wild birds. For example, from January 1996 to July 1998, according to a study by the Animal Welfare Institute, 273,288 birds were imported, based on U.S. Fish and Wildlife Service import data and U.S. Department of Agriculture bird quarantine forms. Of those, an estimated 70 percent, or 191,324 birds, were captive-bred canaries, finches, budgerigars and cockatiels. Some illegalities were noted, such as the import of some 1,379 wild parrots from Latin America, of which only 457 were seized. Most of the other wild birds were finches from Tanzania, China and Vietnam. Since this study was done, China has ceased exporting wild birds. The study uncovered the need for a better system of recording bird imports by the Fish and Wildlife Service to assure accuracy and allow proper enforcement of the WBCA as well as CITES, the Endangered Species Act and other legislation. The data entry system of the Fish and Wildlife Service is based on a letter code assigned to individual species, but a large number of entries at the ports of entry were found to be inaccurate, and there was insufficient oversight at headquarters.

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More than 40 species of birds have become endangered by the pet and aviculture trade, and many more have declined to threatened status. The spectacular, large pink Salmon-crested or Moluccan Cockatoo (*Cacatua moluccensis*) of Indonesia is endemic to the island of Seram and its satellite islands in the Moluccan Islands. In the 1980s, international exploitation began with thousands exported yearly, the majority to the United States. Although once considered abundant in its restricted range, the overall population could not withstand such high rates of capture. The Indonesian government placed an export quota of 5,000 in 1988, and 3,000 in 1989. These high quotas were not based on scientific surveys of the birds™ populations. In 1989, U.S. imports alone totaled 5,252 Salmon-crested Cockatoos, exceeding the export quota by 2,252 birds, a clear indication that the Indonesian government had not

controlled this trade. Between 1980 and 1990, when U.S. imports finally ended, 43,083 of these beautiful parrots had been imported, threatening this species with extinction; thousands had died in capture, transport and quarantine. World trade in the 1980s may have totaled as many as 100,000 birds. In 1989, the Salmon-crested Cockatoo was finally listed on CITES Appendix I, banning international commercial trade. *Threatened Birds of the World*, compiled by BirdLife International, classifies this species as Vulnerable and in a decline that is expected to continue (BI 2000).

During the 1990s, Salmon-crested Cockatoo populations did not recover as a result of the new protection accorded, but surveys found that this species had disappeared from several islands within its range and had become confined to Seram, where it declined 20 to 40 percent during the 1990s (BI 2000). In spite of the CITES Appendix I listing and an Indonesian export ban, Salmon-crested Cockatoos continued to be illegally captured on Seram. The Royal Society for the Protection of Birds (RSPB) filmed the capture of these cockatoos on their roosting trees at night in the early 1990s. When caught by the feet, these birds shrieked in terror. This film, entitled fiBird Trafficfl (see Video Section), chronicles this poaching and subsequent smuggling out of Indonesia. The RSPB researchers found that local villagers within the range of this cockatoo had not been informed by the government of the species' rarity and legal protection, with the result that villagers willingly captured them when logging company employees placed orders. Outside Manusela National Park, these cockatoos are extremely rare, and their rainforest habitats are being destroyed by logging (BI 2000). Captive birds now far outnumber wild populations. Salmon-crested Cockatoos are no longer imported into the United States or Europe but are still sold in Asian markets. Should this beautiful cockatoo become extinct in the wild, the U.S. market will have to bear much of the blame, having been responsible for depleting a once common species. Wild-caught specimens of these magnificent birds are still seen in U.S. pet stores, exhibiting extremely neurotic behavior reflecting their inability to adapt to living in a tiny cage. They bob in circles while shrieking loudly, or shift rapidly from one foot to another, continuing this behavior for long periods.

Equally high quotas for other species of Indonesia's beautiful parrots and lories ended in endangering many species. By the end of the 1980s, five species of large Asian cockatoos, Salmon-crested, White (*Cacatua alba*), Goffin's (*Cacatua goffini*), Yellow-crested (*Cacatua sulphurea*), and Philippine (or Red-vented) Cockatoos (*Cacatua haematuropygia*), had become threatened with extinction as a direct result of massive, uncontrolled capture for the pet trade (Collar *et al.* 1994). Only the Goffin's, Salmon-crested and Red-vented Cockatoos are listed on Appendix I of CITES. The Yellow-crested Cockatoo, endemic to a small range in East Timor, Sulawesi and nearby islands, is now Critically Endangered, in imminent danger of extinction (BI 2000). As noted in *Threatened Birds of the World* (BI 2000), "Its precipitous decline is almost entirely attributable to unsustainable exploitation for internal and international trade." Logging, pesticide use and persecution have also played roles. This white cockatoo with yellow crest was imported into the United States in very large numbers for the cage bird trade during the 1980s. Although a program to recover its populations and preserve them in the national parks and reserves where they occur has been adopted, CITES Appendix I listing would provide additional protection. In parts of Indonesia, ecotourism based on bird watching is being developed. This country has an enormous variety of beautiful, dramatic and colorful parrots and other endemic birds.

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In the early 1980s, Bolivia was the largest exporter of parrots from South America, illegally transshipping the protected birds of neighboring countries, and depleting its own parrot populations. The Red-fronted Macaw (*Ara rubrogenys*) and the Blue-throated Macaw (*Ara glaucogularis*), for example, are endemic to Bolivia, and trade nearly extinguished their already small populations. These birds are now on Appendix I but are at risk of extinction. In 1984, the Government of Bolivia publicly admitted that its wildlife export trade was out of control, its bird exporters funneling protected birds from neighboring countries, and its own CITES personnel had forged export permits. A temporary export ban was enacted, and this later became permanent--to the great credit of this country, which harbors a wealth of bird life and extensive tropical forest. The Red-fronted Macaw, imported into the United States in the

hundreds during the 1980s, is now Endangered in the *2000 IUCN Red List of Threatened Species*. Its population has declined to as few as 1,000 birds, with continued illegal capture for wealthy bird collectors (BI 2000). The Blue-throated Macaw, native to northern Bolivian rainforests, is in Critically Endangered status, according to IUCN and BirdLife International with fewer than 249 birds left in the wild; it, too, continues to be illegally captured for trade (BI 2000). A 1984 study by two South American biologists, Manuel Nores and Dario Yzurieta (1984), found that eight of the 11 macaw species in Bolivia were endangered, rare or declining as a direct result of the wild bird trade. Bolivia's forests are largely intact, and the enormous trade in wild parrots during the 1980s is the sole explanation for the depletion of all the large parrots and many of the small ones in that country.

Numerous other Latin American parrots, once common, were so heavily traded in the 1980s that they, too, became threatened with extinction and were listed on CITES Appendix I. Among these is the beautiful Scarlet Macaw, symbol of tropical forests, which was listed in 1985, along with the Military Macaw (*Ara militaris*) and the similar Great Green or Illiger's Macaw (*Ara ambigua*), all being overexploited for the pet trade (BI 2000). The Scarlet Macaw has disappeared from areas close to villages and towns throughout its large range, which extends from southern Mexico to Amazonian South America. In Mexico and Central America, it has been protected from trade since the early 1980s, but illegal capture and smuggling continue to decimate wild populations. With passage of the Wild Bird Conservation Act, this species is now more secure, making illegal sales in U.S. pet stores much more conspicuous. By the end of the 1980s, 10 of the 17 macaw species had been listed on Appendix I of CITES, and others were experiencing steep declines.

Further west in Peru's massive Manu National Park, biologist Charles Munn has been studying macaws and parrots since 1984, climbing 100-foot trees to observe them closely, locating wild nests and researching their productivity. He found that in spite of the undisturbed extensive rainforest habitat in the park, large macaws raise very few young; 100 pairs of large macaws might fledge as few as 15 to 25 young per year (Munn 1988). He concluded, "Such a low reproductive rate indicates that macaws *cannot* be harvested from the wild without depleting their populations." This explains how species of macaws and parrots that had flown in huge flocks of hundreds of birds became reduced to scattered numbers within a few years after the onslaught of the parrot traders. Another factor in the vulnerability of parrots is their refusal to leave trapped flock-mates. Trappers would continue capturing birds that flew to the aid of their fellows until entire flocks were caught. North America's only native parrot, the Carolina Parakeet, had this trait as well and was trapped to extinction.

Trapping breaks bonds between lifelong mates and leaves females with chicks that often starve when the male is caught. This cruel trade causes the premature deaths of thousands of parrots from disease, improper care and stress. Methods of capture are particularly inhumane. Some trappers set nooses on tree limbs that flip the bird upside down when its foot becomes trapped. Birds can remain caught in this manner for hours or days, screaming and flapping their wings, while fellow parrots gather around squawking helplessly, unable to free them. Other parrots and many types of small finches are caught by bird lime, an adhesive that is smeared on tree branches. Birds' wings or feet become stuck to the branches, and they struggle in vain to free themselves, often resulting in injury or death. Decoy birds are also used to attract flocks to baited nets which are sprung by a trapper hidden in the bushes. So efficient are these methods that trappers nearly caused the extinction of South American Military Macaws that congregated annually when the fruit of a certain type of tree in northwestern Argentina ripened. The flock members returned annually to this ancestral feeding area, and trappers set nooses on and near these trees, using decoy birds to attract them. Only CITES Appendix I listing saved the remnant population of these magnificent birds from extinction. The taking of nestling parrots from tree holes, often cutting down entire nest trees in the process, is another method of capture that had extremely serious consequences for the once abundant Blue-fronted Amazon (*Amazona aestiva*) of Argentina (Bucher and Martella 1986), so depleted that only the threat of a CITES Appendix I listing forced the Argentinean government to enact an export ban, which remains in force.

The world's largest parrot, the beautiful Hyacinth Macaw (*Anodorhynchus hyacinthinus*), is another casualty of the cage bird trade. These magnificent cobalt blue parrots, more than 3 feet long, are native to open, palm-studded grassland and gallery forests of west-central Brazil, with small populations in neighboring Bolivia and possibly

Paraguay. They are endangered by a totally illegal bird trade. From an original population estimated in the hundreds of thousands, the species has been reduced to between 3,000 and 5,000 birds. The United States imported a minimum of 2,130 Hyacinth Macaws between 1977 and 1988, and thousands more were imported by European countries. These birds were imported under "legal" papers from Bolivia and Argentina during the early 1980s, having been illegally captured in Brazil, which bans export of all its native birds. Bolivia has a very small population of fewer than 100 Hyacinth Macaws, yet thousands were exported from that country, listed as native on CITES documents. Transshipment of this type has nearly decimated many species of wild birds. They were sold in U.S. pet stores for $10,000 or more per bird, and shown on television shows, which whetted the public's appetite to possess these beautiful birds. Bolivia's 1984 export ban and the listing of the Hyacinth Macaw on Appendix I of CITES in 1987 stopped the disastrous "legal" trade, but unfortunately, many continue to be smuggled. Their status is now Endangered, and declining, with fewer than 10,000 birds remaining in the wild (BI 2000).

Of three other blue macaws native to South America, one is extinct, and the other two verge on extinction. The Glaucous Macaw (*Anodorhynchus glaucus*) has not been seen this century. It was the smallest of South America's three blue macaws and, in the 18th and 19th centuries, was considered numerous along major rivers in southeastern Brazil, adjacent Paraguay, northern Argentina and perhaps Uruguay (Forshaw 1989). Captured for the cage bird trade and zoos in the 19th century, trade may have caused its extinction, since its habitat remains intact (Forshaw 1989). There are continued rumors of sightings, and BirdLife International includes it in *Threatened Birds of the World* (BI 2000) as Critically Endangered.

Lear's Macaw (*Anodorhynchus leari*), which inhabits an arid, rugged terrain in northeastern Bahia, Brazil, numbers fewer than 150 birds (BI 2000). Although a few specimens had been captured in the mid-19th century, the bird was not seen in the wild by ornithologists until 1978 when Dr. Helmut Sick, a Brazilian ornithologist, finally located a small population of about 60 birds; two more tiny populations of 14 and three birds were discovered in the early 1990s a few hundred kilometers away (Collar *et al*. 1994). The main population numbered about 117 birds in 1995, but illegal trapping took as many as 25 birds in the late 1990s. In May 1999, three of these macaws were seized in a raid in North Yorkshire after being smuggled into England (*TRAFFIC Bulletin* 1999). This species faces extinction in the near future from destruction of its licuri palm trees, which provide its major palm fruit diet, hunting by local people and illegal capture for aviculture collections (BI 2000, Collar *et al*. 1994). Only a portion of the Lear's Macaw's habitat is protected by a reserve (BI 2000).

The fourth blue macaw, Spix's Macaw (*Anodorhynchus spixii*), is the most endangered bird in the world. Endemic to a very small area of northern Bahia, an arid region of northeast Brazil, hundreds of these macaws were smuggled out of Brazil in spite of being officially protected from capture, trade and export since 1967; it was listed both on the U.S. Endangered Species Act and CITES Appendix I by 1975, but this did not discourage unscrupulous aviculturists and zoos who offered prices as high as $40,000 per bird. By 1986, only three birds were known to remain in the wild (da Re 1995), and these were illegally captured by 1988. In 1990 a single male bird was discovered, the very last wild bird of his species. With no females of his species left in the wild, he began courting another species of macaw, a female Blue-winged Macaw (*Ara maracana*). A captive female Spix's Macaw was released to the wild in 1995 in the hope that they would breed, but although the two birds stayed together for a short period, they then separated and the male returned to the Blue-winged Macaw (da Re 1995). The female Spix's Macaw disappeared altogether, and is thought to have collided with a power-line (BI 2000). While kept in a zoo, this female macaw had been paired with a male, who remains in captivity (da Re 1995). Eggs laid by captive Spix's Macaws were to be placed in their nest in 2001 to be raised by this pair (BI 2000). However, this last wild Spix's Macaw, a repository for the knowledge and skills of survival for his species and crucial to the success of future releases, was illegally captured in the Fall of 2000, rendering the species extinct in the wild. Some people hope that others of his species remain undetected, since the original habitat is extensive.

About 60 wild-caught Spix's Macaws are in captivity (BI 2000), and they could provide additional vital genes and experience for reestablishment of the species. Most of these are captive-bred, and may be inbred because they descend from only ten wild macaws (da Re 1995). Undoubtedly, many more Spix's Macaws are held in unknown locations by private collectors who purchased these smuggled birds. This species' habitat of gallery forests near the Sao Francisco River has become degraded by tree cutting and livestock overgrazing, preventing the growth of young trees (da Re 1995). Only 30 square kilometers of this gallery forest remains in three fragments (BI 2000). Although the remaining wild birds are being guarded by rangers, no reserve has been established. The smuggling of these birds continues. In April 1995, three Spix's Macaws that had been illegally captured in prior years were confiscated in Chile as they were being smuggled to Russia, according to the World Society for the Protection of Animals (WSPA). The Costa Rican representative of WSPA flew with the birds to Sao Paulo, Brazil, where they were placed in the zoo with others of this species. The Spix's Macaw is an extreme example of the avid pursuit of rare birds by aviculturists--and even zoos--in defiance of all national and international protective legislation. Some of the individuals who obtained these birds illegally have refused to donate their birds to breeding projects, even though the species' status could not be more precarious. Other Spix's Macaws are possessed in secret, and owners have not stepped forward to allow their birds to be part of a cooperative breeding program.

These cases represent the tip of the iceberg of birds that have been threatened by the cage bird trade. Many island species have been endangered by this trade. Amazon parrots from Caribbean islands are among the most coveted of birds. The magnificent Imperial Amazon (*Amazona imperialis*), a highly endangered endemic from Dominica, has iridescent purple and green feathers, making it one of the most beautiful of parrots. Smugglers have paid as much as $50,000 for a single Imperial Amazon, which now number only about 300 birds in the wild. Fortunately, it is finally increasing, and a new national park protects a portion of this endangered bird's population (BI 2000). The St. Vincent Amazon (*Amazona guildingii*), of the island of St. Vincent, is the most numerous of the endangered Caribbean amazons, numbering about 800 birds as of 1994 (BI 2000). The rarest is the Puerto Rican Amazon (*Amazona vittata*), which declined from a population of 2,000 in the 1930s to about 41 birds in 1993, in large part due to illegal capture for the pet trade (Collar *et al*. 1994). It numbered 44 birds in the wild and 87 in captivity in 1996 (BI 2000). Once reduced to small numbers, many parrot species, like the Puerto Rican Amazon, do not recover. This parrot's population has not increased substantially in spite of legal protection for almost a century and an intensive conservation program. There is still a demand for Caribbean parrots, with collectors offering $20,000 or more per bird for smuggled specimens. In the book, *The Parrots of Luqillo: Natural History and Conservation of the Puerto Rican Parrot* (Snyder *et al*. 1987), the authors state: "Clearly, the high price that some aviculturists are willing to pay for rare parrots is one of the most serious threats to survival faced by the West Indian *Amazona*. It is ironic that the rationalization often used by such individuals for obtaining rare species is that they hope to 'save' them from extinction by captive propagation" (Snyder *et al*. 1987).

For one Caribbean parrot, the future is brighter. A very successful conservation program is bringing the St. Lucia Amazon (*Amazona versicolor*), endemic to the island of St. Lucia, back from near-extinction. This parrot was in steep decline until a biologist, Paul Butler, working for RARE Center for Tropical Bird Conservation in Philadelphia, Pennsylvania, began a long term project to prevent its extinction. From 150 birds in 1976, the population has risen to 200 to 250 birds in 1990 (Butler 1992), to 300 to 350 in 1996 (BI 2000). The program educated children in grade schools using songs, parrot costumes and puppets, and enlisted the help of many local businesses to use the bird as their logo or in their ads. In 1979, the St. Lucia Amazon was named the country™s official bird (Butler 1992). Posters and billboards illustrating St. Lucia Amazons were put up in public places throughout the island, and the program has sought to identify the species with national pride. Its protection is now a concern of most members of the public, and this enthusiasm to protect "their" parrot has made illegal capture and shooting almost unknown (Butler 1992). Paul

Butler's work has been so successful that he carried his program to St. Vincent to protect its native parrot, and to other islands for programs conserving their native birds (Butler 1992). The National Audubon Society's film, fiCaribbean Cool,fl about Butler's work on St. Lucia, shows the beautiful St. Lucia Amazon and programs in schools in the Caribbean region (see Video, Activism and Attitudes).

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A bird that has proven almost impossible to protect from bird trappers is the lovely, white Bali Starling or Rothschild's Myna (*Leucopsar rothschildi*), endemic to the island of Bali, Indonesia. It is now confined to a tiny area on the island's extreme northwest tip inside the Bali Barat National Park. By 1990, the wild population had been reduced to 13 birds, although the captive population was about 700 (Collar *et al*. 1994). The Bali Starling Project sought to reintroduce captive birds and reinforce guarding of the park. By 1994, the population had risen to between 35 and 55, but poaching continued, off-setting gains of successful breeding (Collar *et al*. 1994). In 1999, the wild population totaled 12 birds; the same year, 39 captive individuals in the park awaiting release to the wild were stolen by an armed gang (BI 2000). The park and conservation program have suffered from mismanagement and corruption, and the price for these birds on the black market has risen to $2,000 a bird (BI 2000). The protection offered these reintroduced birds has been inadequate, and possibly involves complicity with poachers by park guards.

The keeping of sparrows and finches is extremely popular in Latin America and parts of Asia. Two songbirds, the Brown-backed (*Myadestes occidentalis*) and Slate-colored Solitaires (*Myadestes unicolor*) in Central America, are heavily trapped, disappearing from many areas. Two ornithologists commented, "It is a sad morning indeed that one experiences forests deprived of these fine songsters" (Howell and Webb 1995). A finch that has long been subjected to bird trapping because it is bred with domestic canaries for "Red Factor Canaries," the Red Siskin (*Carduelis cucullata*), of northern Venezuela and a small area in Colombia, has become endangered from this illegal trade (Collar *et al.* 1994). This bright red bird requires moist evergreen forest, dry deciduous woodland and shrubby grassland habitat, moving from one to another seasonally. It has disappeared from Trinidad and from almost all its original range in Venezuela and Colombia (Collar *et al*. 1994) and is listed as Endangered by the *2000 IUCN Red List of Threatened Species* and the U.S. Endangered Species Act. It is also listed on Appendix I of CITES.

Steve Howell and Sophie Webb (1995), authors of a guidebook on birds of Mexico and northern Central America, commented on the bird trade in Latin America: "Paradoxically, keeping parrots and songbirds in cages about the house is considered an appreciation of nature. Sadly, the desire to have birds, particularly parrots, as pets has spread far beyond Middle America . . . Within 20 years or less, we predict that wild Scarlet Macaws and Yellow-headed Parrots may be things of the past in Mexico."

The Java Sparrow (*Padda oryzivora*), endemic to the Indonesian islands of Java, Bali and Kangean, once flocked in large numbers to towns, villages, gardens and agriculture fields. Within the past few years, however, it has undergone a precipitous decline as a direct result of heavy trapping for the cage bird trade and has become scarce, listed as Vulnerable in BirdLife International's (2000) *Threatened Birds of the World* and by the IUCN. It is not listed on CITES. In 1995, an embargo on exports from Java and Bali was put in place by the Indonesian government, and the species occurs in several national parks (BI 2000).

Sold for a Song. The Trade in Southeast Asian Non-CITES Birds, by Stephen V. Nash (1993), found that a number of birds not protected by CITES were threatened by the trade. For the most part, the species and numbers involved in the Asian bird trade are undocumented (Nash 1993b). The dual threats of bird trapping and habitat loss are causing declines in many Southeast Asian birds. Endemic species can become endangered by relatively low levels of trade because of their limited habitat. For Asian finches and other species not listed on CITES, most trade is legal, with little concern for their status in the wild. In Southeast Asia, the majority of countries allow capture and sale of wild

birds. The few countries that ban trade in wild birds, such as Thailand, have not shut down illegal bird markets in Bangkok and other cities. In Bangkok's Jatujak Market, on a given day, 616 species of native birds are offered for sale (Nash 1993b). Most Western bird owners would be startled at the types of birds sold in these markets. Although doves and finches are sold in great numbers, partridges, pheasants, geese, and barbets are offered, as well as species totally unsuited to captivity, including kingfishers, bee-eaters, storks, woodpeckers and flycatchers. Native birds that are not listed on CITES lack any protection in Indonesia, Vietnam, Laos, and Cambodia (Nash 1993b). Nowhere else in the world are there so many endemic bird species with so many countries in the region that fail to protect them, or that serve as exporters of non-native birds, such as Hong Kong and Singapore.

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Although the United States has strict laws prohibiting importation of endangered birds without permits, some aviculturists have managed to smuggle birds by using complex and clandestine routes. One truly stunning case was the indictment in 1994 of Tony Silva, an aviculturist who had represented himself as a parrot conservationist, and served as Curator of Birds at Loro Parque, a parrot zoo in the Canary Islands. This zoo has many endangered birds, including several Spix's Macaws, which have never been legally exported from Brazil, either for zoos or any other purpose. Silva was caught in a Fish and Wildlife Service Law Enforcement sting called fiOperation Renegade,fl after search warrants were issued on business records in his home and that of his mother. Searches of their premises uncovered documentation of a major smuggling operation specializing in endangered birds. Silva and his mother, who was also indicted, conspired to smuggle numerous rare birds from 1985 onward with the cooperation of a Paraguayan citizen who was also indicted, as was Hector Ugalde, a Miami citizen who aided in the conspiracy (USDJ 1994). Silva earned an estimated $1.3 million from this smuggling. Among the CITES Appendix I birds smuggled were 186 Hyacinth Macaws, seven Blue-throated Conures (*Pyrrhura cruenta*), several highly endangered Vinaceous Amazons (*Amazona vinacea*), and two endangered Golden Conures (*Aratinga guarouba*), the latter being one of the most coveted of all birds by collectors. The latter three species are also listed on the U.S. Endangered Species Act. Silva also smuggled Red-fronted and Great Green Macaws, listed on CITES Appendix I and extremely rare in the wild. Other rare species smuggled by Silva included three protected Brazilian Crimson-bellied Conures (*Pyrrhura rhodogaster*) and another Brazilian bird, and threatened Yellow-faced Amazons (*Amazona xanthops*), along with several endangered primates. Silva also illegally exported Gray Parrots from the United States to New Zealand and smuggled two endangered Red-vented Cockatoos from the Philippines, according to the indictment. In 1987, Silva received an illegal shipment of nine protected Chilean Flamingos (*Phoenicopterus chilensis*), a CITES Appendix II species (USDJ 1994). He smuggled three endangered Yellow-shouldered Amazons (*Amazona barbadensis*) as well.

According to Fish and Wildlife Service Law Enforcement agents, Silva and his co-conspirators were the foremost illegal dealers in rare birds during the entire decade of the 1990s. Lois J. Schiffer, Assistant Attorney General in charge of the Justice Department's Environment and Natural Resources Division, said: "The defendants were involved in nothing less than plundering the national treasures of other countries. These crimes threaten not only our ability but that of the international community to protect endangered species and global biodiversity" (USDJ 1996). An affidavit by an undercover Fish and Wildlife Service Special Agent (Marks 1992) attested that Silva had invited an unnamed source to his home and showed him resin-like glue that was extracted from a certain species of tree and was used in South America for the express purpose of trapping Hyacinth Macaws. Silva showed the source photographs of rare parrots dyed to look like other species of birds to avoid detection in transport. Enrique Basan, an unindicted co-conspirator who resided in Brazil, trapped many of these endangered birds and shipped them to Gisela Caseres in Paraguay, who then smuggled them to the United States (USDJ 1994).

The Hyacinth Macaws were then transported by charter aircraft and across the Mexican border, placed in PVC plastic tubing and hidden in car door panels. Many died of suffocation and overheating on the way. Some smuggled parrots were placed in false-bottomed suitcases under mounds of clothing. In 1989, wasting disease ravaged Silva's

aviary, killing many of the surviving rare birds, which he kept in a basement aviary (Marks 1992). Silva shipped 35 of the smuggled Hyacinth Macaws to Mario Tabraue, who spent time in prison on a 100-year sentence for murder and drug-related crimes. Prior to his conviction, he ran a quarantine station and wildlife importation business known as Zoological Imports. Tabraue paid Silva and his mother $100,000 for this shipment and had previously bought other smuggled animals; he would then offer the wildlife for sale in interstate and foreign commerce (USDJ 1994). All the macaws were dead on arrival (Marks 1992). Silva used closed legbands to identify fraudulently smuggled Hyacinth Macaw chicks as bred in captivity, and conspired with a bird importer, Larry Lafeber of Rosemont, Illinois, to use the latter's quarantine facilities to launder smuggled wildlife. He and Silva illegally removed U.S. Department of Agriculture quarantine seals from Lafeber's station to take smuggled wildlife out of the station. Lafeber also forged health certificates for two smuggled Hyacinth Macaws (USDJ 1994).

Silva wrote a book on endangered parrots, in which he described the Hyacinth Macaw as being "worth its weight in gold," and regularly gave lectures on parrots, presenting himself as a conservationist. In a 1991 article on the Hyacinth Macaw, he stated, "Unless all of the pressures are brought under control, this species may be unable to survive in the world to greet the 21st century" (USDJ 1996). In fact, he contributed to its endangered status. With its very slow reproduction rate, lack of protected reserves or parks in its range, and continued threats by hunters and destruction of its nesting trees, this beautiful macaw may indeed fade into extinction as a result of smuggling. Since these birds are easily recognized, and the CITES listing ended legal trade, only an extremely well-financed operation such as that conducted by Silva, involving the use of small aircraft that carried the birds from remote parts of South America to Mexico where they were smuggled over the border, could have succeeded in obtaining these birds. Australian government studies have documented that up to 10 birds die for every bird that survives smuggling, and most operations incur a mortality rate of 80 percent (PCA 1976). The Fish and Wildlife Service investigation uncovered high mortalities among the macaws Silva smuggled and, thus, he is probably responsible for the deaths of 1,860 (10 times the 186 for which he was indicted) of these rare birds.

Silva had warned of the serious consequences of rampant poaching of wild birds in a 1991 speech at the Parrot Symposium International (*The New York Times* 1996), and in a November 1995 interview, he stated, "I love birds. I could never be involved in anything that killed them" (*The New York Times* 1996). Through his smuggling, Silva was responsible for the deaths of hundreds--and perhaps thousands--of birds, of which the majority were rare and endangered species. Prior to the indictment, but after it was revealed that he was being investigated, he was interviewed by the public television station WGBH in Boston for a NOVA program, *The Great Wildlife Heist* (1994); he made statements admitting an uncontrollable desire to own rare birds (See Video - Trade).

Smuggling is the cruelest activity associated with the bird trade. Smugglers have used hundreds of concealment techniques to avoid detection when crossing borders. These include placing small birds in the center of hair curlers stacked in enclosed boxes or suitcases; stuffing parrots inside
tire wells and even hubcaps in cars; and placing them inside clothing being worn and in stifling secret compartments in shipping crates and suitcases. Birds are smuggled on rafts across the Rio Grande River, and in many cases, the rafts have overturned and the birds drowned. Sometimes when smugglers believe that they have been spotted by law enforcement officers, they kill the birds they are smuggling by intentionally drowning them or throwing them out of moving cars. Often the birds are wrapped tightly, with their wings unable to spread and their beaks taped. They die of overheating.

Silva faced a combined maximum prison term of 45 years and a maximum total fine of $2.5 million, but he reached a plea bargain with the Justice Department the day his trial was to begin in January 1996. In early June, he was jailed as a flight risk prior to sentencing. Because he was fluent in Spanish and had many contacts in other countries, the Justice Department was convinced that, in spite of the fact that a lien had been placed on his house and his passport had been seized, he might leave the country to avoid going to jail. His plea of guilty to conspiracy to violate wildlife and Customs laws, and filing a false income tax return, resulted in the longest prison term ever given to a bird smuggler, handed down in late 1996: 6 years and 10 months. His mother received a sentence of 27 months in jail. This case, like other smuggling cases in fiOperation Renegade,fl was based on a long investigation which uncovered

indisputable proof of the Silvas' guilt, as have many such indictments. Most, however, end in penalties far below what would be allowed by law. Judge Elaine Bucklo of the U.S. District Court, Northern District of Illinois, deserves considerable praise for rendering this stiff jail sentence, and also for ruling that Silva be jailed for six months prior to the sentencing. In another fiOperation Renegadefl case involving the indictment of a Florida bird importer, Louie Mantas, the defendant left the country prior to the commencement of his trial and is now a fugitive with outstanding warrants for his arrest.

Much progress has been made in giving longer sentences to wildlife smugglers. A decade ago, jail sentences for wildlife crimes were virtually unknown. New sentencing guidelines enacted by Congress recommending higher penalties have had a major role in the imposition of longer jail sentences, and judges have begun taking these crimes far more seriously than in the past.

Wild Pets and Laboratory Animals: Primates

All gibbons, tailless apes of the Hylobatidae family, are endangered, listed on Appendix I of CITES and as Endangered on the U.S. Endangered Species Act. Ten species are listed in the *2000 IUCN Red List of Threatened Species*. Gibbons inhabit the rainforests of Southeast Asia, where they have declined as a result of logging and capture for the zoo and pet trades. They communicate in whoops and haunting songs that carry for miles in the forest, and they mate for life. Their long, spidery legs and arms give them great agility as they leap large distances between trees. Until the 1970s, thousands of gibbons were imported by U.S. zoos and laboratories. CITES Appendix I listing stopped this trade, but in Asia, they are still captured for the pet trade, and babies are used to pose for photos with tourists. This trade involves the killing of many mother gibbons in order to obtain a few baby gibbons, which are so poorly treated that most die within months. In Thailand, there were an estimated 1 million gibbons as recently as 1975, but only a fraction of that number survives today. Thai forests have become fragmented, and old growth, which most species require for habitat, is nearly gone. Thailand is a country that now has laws prohibiting logging and capture and sale of most native wildlife, but enforcement is very weak. Gibbons are sometimes used as mascots in bars and stores. This is often done in the evenings on busy streets, and the gibbons are given drugs to keep them awake. In Bangkok, Leonie Vejajiva has worked for 20 years to rescue these orphaned and mistreated gibbons. Some are abandoned by their owners when they grow too large, and others are confiscated by wildlife authorities. Vejajiva estimates that 20 mothers and 19 babies are killed to get one baby for sale. The gibbons in her care have been very traumatized and abused. One is missing a finger and had all his teeth filed down to the gums to prevent him from biting. Pileated Gibbons (*Hylobates pileatus*), native to Cambodia, Laos and Thailand, are so endangered that 15,000 at most remain in the wild. Vejajiva has taken in many Pileated Gibbons, and one female had been owned by someone who put cigarettes out on her back and beat her for years. It has taken a long time for her to trust Leonie, but she remains angry and hates men. Leonie has seen her gibbons show great emotions and pine away when sad, and considers them extremely emotional and sensitive. The Thai government recently set aside a tract of 80 acres where confiscated gibbons can be kept in large, treed enclosures.

Other primates are captured for the pet trade throughout the tropics. Most countries have laws banning this practice, but it continues, nevertheless. In Vietnam, it is illegal to capture native primates, but baby macaques are commonly seen by the roadside, offered for sale by hunters who have shot the mothers. In cities, these pathetic, underfed and traumatized monkeys are kept in tiny, dirty cages and sold as pets to locals and tourists. Vietnam is exploiting its wildlife commercially on an unprecedented scale. Markets in Ho Chi Minh City and other cities offer many primates for sale, even including gibbons, and thousands are exported for the pet and laboratory trades.

In many countries, regulations ban importation of primates for the pet trade because the Public Health Services have deemed them to be a health hazard to humans. They can spread rabies and many respiratory diseases. Importation of primates for the pet trade was banned in Denmark in 1965; in the United States in 1975; and in

Finland, West Germany, Italy and Switzerland during the 1960s and 1970s (Fitzgerald 1989). Pet monkeys are still occasionally seen advertised, however, and many are brought into the United States and other countries illegally by travelers to tropical countries.

In the 1950s, 15 million monkeys were exported annually from tropical countries for medical research, primarily to develop a polio vaccine, endangering a number of species. During the 1960s, many South American countries banned commercial exports of their wildlife, but exports of primates continued. Conservationists began protesting the enormous drain on wild primate populations, and humane organizations protested the cruel treatment they received. The U.S. Endangered Species Act of 1973 listed a number of species, banning their importation, but some countries continued to export primates for this trade. Laboratory dealers would switch from one species to another to continue high imports. The U.S. Congress enacted the Laboratory Animal Welfare Act in 1966 (later renamed the Animal Welfare Act) with standards for the care of monkeys and other animals used in research. When CITES came into force in 1975, the trade was restricted greatly. All primates are now listed on either Appendix I or II. By 1979, the world primate trade dropped to 65,000 per year (Fitzgerald 1989). In the 1980s, African monkeys and Asian macaques became the major laboratory primates. These animals were often subjected to extremely cruel and unnecessary experiments. American taxpayers financed hundreds of these through grants from the National Institutes of Health. Many laboratory monkeys are now bred in captivity, yet thousands continue to be captured for the laboratory animal trade.

Almost 50,000 primates were listed by the Department of Agriculture as used in research in U.S. laboratories in 1993, according to a study by the International Primate Protection League; 19,461 of these primates were used in research causing pain and distress alleviated by drugs; and 1,353 were used in experiments causing pain and distress *not* alleviated by drugs (*IPPL News* 1995). Many of these animals are endangered species such as Chimpanzees, kept in isolated, sterile cages and used in AIDS research.

There are approximately 1,500 Chimpanzees in U.S. laboratories. The Coulston Foundation is a facility that maintains hundreds of these intelligent primates, with a record of high mortality, poor care and more than 40 violations under the Animal Welfare Act of 1966. In May 2000, the National Institutes of Health (NIH) took title to 288 Chimpanzees. Coulston tried to get them back, and NIH decided to leave them in the facility prior to a final decision about their fate. During this period, one 10-year-old Chimpanzee died after "allegedly being left sick for days without receiving veterinary care" (AWI 2001). In spite of its record, NIH continues to award funds to The Coulston Foundation, preventing its bankruptcy (AWI 2001). The 600 Chimpanzees at this foundation need to be transferred to a sanctuary where they would receive needed veterinary treatment and compassionate care (AWI 2001).

Many laboratories have made public statements indicating that when they have completed research studies on these Chimpanzees, the animals will be euthanized. Humane organizations have loudly protested this, and campaigns are being waged to place these animals in spacious enclosures so that at least the last years of their lives will be spent without trauma. When the New York University Medical Center disbanded its animal research laboratory, it planned to donate its Chimpanzees to The Coulston Foundation. Dr. Jim Mahoney, veterinarian for these primates, took it upon himself to place them in humane surroundings where they would never be experimented on again. At his own expense, even driving them to the centers in a special van, he found homes for 90 Chimpanzees in various rescue centers, including Primarily Primates in Texas and a center in Quebec where they could socialize in large areas with sleeping shelves, toys, soft blankets and jungle bars. One Chimpanzee who had never slept anywhere except the cold cement floor of his cage or felt a soft object, hugged a blanket, rolling in it in joy when he first entered the sanctuary. Jane Goodall encouraged this project and spoke of the need to treat these very sensitive animals with respect and kindness on a National Geographic Explorer program, *Chimp Rescue*, shown in November, 1998, which traced Dr. Mahoney's steps in rescuing the chimps as well as 100 monkeys.

The Chimpanzee Health Improvement, Maintenance, and Protection Act, signed into law in 2000, will facilitate projects such as Dr. Mahoney's. It will provide $30 million from the budget of the National Institutes of Health to

establish a national system of sanctuaries to provide for the long-term care of Chimpanzees no longer needed in biomedical research.

Wild Pets and Laboratory Animals: Land Turtle and Tortoise Pets

In Europe there is a sizeable market for pet tortoises and land turtles. The Mediterranean area--Greece, the Mideast and North Africa--provided millions of tortoises for decades. The Royal Society for the Prevention of Cruelty to Animals (RSPCA) investigated this trade in the 1970s and found a mortality rate of more than 80 percent in the first year of captivity (RSPCA 1980). A 1982 study found that 92 percent of 2,000 tortoises imported did not survive more than three years in captivity (Fitzgerald 1989). The number of tortoises involved was astounding--almost 2 million Spur-thighed Tortoises (*Testudo graeca*) were imported for the British pet trade between 1965 and 1977 (RSPCA 1980). More than 350,000 Hermann's Tortoises (*Testudo hermanni*), native to the northern Mediterranean, were imported during the same period (RSPCA 1980), and this species was categorized by the IUCN in 2000 as Near-Threatened (Baillie and Groombridge 1996). A species from Afghanistan, Iran, Russia and other countries of Central Asia, Horsfield's Tortoise (*Testudo horsfieldii*), has been collected in enormous numbers; 150,000 per year are taken from the wild, with nearly 100,000 exported to western Europe (Fitzgerald 1989). It is now listed as Vulnerable by the IUCN. All these species have declined precipitously in the wild (Fitzgerald 1989), and these slow-reproducing species rarely rebound quickly, even after receiving protection.

Because of the heavy exploitation of these land tortoises for the pet trade, the entire genus *Testudo* was placed on Appendix II of CITES in 1975, but this scarcely slowed the trade. Some import restrictions were enacted in 1979 by the United Kingdom, and internal trade and possession of Spur-thighed, Hermann's and Marginated Tortoises became prohibited under the 1982 Convention on the Conservation of European Wildlife and Natural Habitats (Fitzgerald 1989). However, these measures served only to slow the trade. A major development occurred when the European Economic Commission (EEC) banned imports of all three species in 1984. Hermann's Tortoises are not fully protected, however. They have been sold in California for $525 each (Fitzgerald 1989). Hundreds of protected Sri Lankan Ceylon Star Tortoises (*Testudo elegans*) were smuggled to an Australian animal dealer in the early 1980s (Fitzgerald 1989). In 1984, the only record for Horsfield's Tortoise trade was 18,000 shipped to Italy from Turkey (Fitzgerald 1989). Trade has switched to Egyptian Tortoises (*Testudo kleinmanni*), native to Egypt, Libya and Israel. This species is now one of the most threatened of Old World tortoises, listed as Endangered by the *2000 IUCN Red List of Threatened Species*. This is the smallest of the *Testudo* tortoises, only 6 inches in length, and is now being exploited only because the other species have reached near extinction.

Bolson's Tortoise (*Gopherus flavomarginatus*), native to a small remnant habitat in northern Mexico, has been decimated by the pet trade and is now listed as Endangered by the U.S. Endangered Species Act to stop imports of these tortoises across the border into the United States. The South American Chaco Tortoise (*Geochelone chilensis*) was imported from Argentina and Paraguay by European traders in the 1980s, prompting Argentina to prohibit exports in 1986 (Fitzgerald 1989).

Following the depletions of the Mediterranean tortoises, the European pet trade began exploitation of North American box turtles, genus *Terrapene*. Terrapin turtles occur in eastern North America and northern Mexico. Box turtles are about 4 to 5 inches long, with yellow geometric patterns on a black background on their shells and bodies. They spend the majority of their lives on land, and the most familiar of these, the Eastern Box Turtle (*Terrapene carolina*), lives in moist deciduous forests and grasslands. The Ornate Box Turtle (*Terrapene ornata*) inhabits grasslands and dryer areas, and the endangered Coahuilan Box Turtle (*Terrapene coahuila*) is strictly aquatic and lives only in the Cuatro Cienegas basin in northern Mexico. Until the early 1990s, the Eastern and Ornate Box Turtles were quite common, although declining from fragmentation and development of their habitat and losses from road traffic and lawn mowers. More than 3,000 Eastern Box turtles were exported from the United States in 1990 to pet dealers in

Europe and Japan, and exports increased exponentially thereafter. Records show that at least 13,585 Eastern Box Turtles were exported in 1991; 26,361 in 1992; and 23,420 in 1993, for a minimum total of 66,366 for the four years. Ornate Box Turtle exports also increased, from 7,018 in 1992 to 7,768 in 1993 (IUCN 1994). Thus, at least 78,152 of these two species of box turtle were exported in these four years alone; they are sold in European pet stores for $100 or more (Lieberman 1994). Herpetologists have been shocked at the numbers of box turtles involved in this trade, and Dr. Michael W. Klemens of the Wildlife Conservation Society said that the pressure from the collection of these turtles is "just disastrous" and "if it continues at the present rate, it is not sustainable" (Stevens 1994).

England has been a major market, as it was for the Mediterranean tortoises. "The British have always been turtle crazy," said Dr. Klemens. The irony is that the English are animal lovers, and yet many apparently fail to realize that the deaths in captivity of these long-lived turtles are a direct result of their captive conditions, improper food and treatment, and that purchasing them contributes to the turtles' endangerment. The Fish and Wildlife Service requested information from scientists and government agencies on North American box turtle status prior to the 1994 CITES meeting and documented that both the Eastern and Ornate Box Turtles are rapidly disappearing as a result of this trade.

Declines have already been recorded for these box turtles in 16 U.S. states, from Massachusetts, Connecticut and New Jersey south to Florida and west to Missouri, Oklahoma and Wisconsin (Liebermen 1994). Many states protect them from capture, and illegal trade has resulted in more than 20 arrests (Lieberman 1994). State regulations differ greatly, making conservation of the species difficult. In Florida, for example, one may possess two box turtles, Virginia allows capture of five turtles, and Mississippi as many as 20. At least 17 of the 28 states where box turtles are found prohibit or regulate commercial trade. In states without regulations, turtles can be possessed, sold or shipped out of state. Suzanne Dohm, President of the New York Turtle and Tortoise Society, which has begun a program of conservation for these turtles, expressed frustration at the legal loopholes allowing these species to decline toward extinction: "That foreign market is absolutely draining us. You can't buy a box turtle legally in New York State, but you can ship thousands of them out of Kennedy Airport. We cry about saving animals, and yet we let situations like this go on. Something's not quite right" (Stevens 1994). Based on information gathered, the United States proposed that the entire genus *Terrapene* be listed on Appendix II, which the CITES Parties did in November 1994. This listing is meant to prevent further overexploitation, since Appendix II requires that exports not be detrimental to the wild populations of a species.

The State of Louisiana applied in 1996 to export two subspecies of the Eastern Box Turtle--Gulf Coast Box Turtles (*Terrapenne carolina major*) and Three-toed Box Turtles (*Terrapenne carolina major*). Fortunately, the U.S. CITES Office of Scientific Authority recommended a zero quota for U.S. exports. Herpetologists have determined from studies of the closely related Ornate Box Turtle that long-term population declines result if total annual adult mortality exceeds 5 percent, according to the Office of Scientific Authority. Moreover, the Authority determined that domestic trade in Louisiana totaled 9,500 Gulf Coast Box Turtles, and 3,800 Three-toed Box Turtles, a significant local market. The high proportion of adults that were collected, and the very slow reproductive potential of the species, led the Scientific Authority to conclude that insufficient information on the Louisiana population exists to allow export that would not result in depletions. They, therefore, recommended a zero quota on exports of North American box turtles, an important step in preserving these animals. The lack of long-term studies showing that these turtles can be collected without harming their wild populations is another argument against the trade.

Added to the declines in wild populations is the cruel treatment these turtles receive. Many die or are greatly weakened when jammed together without food or water for shipping. A Fish and Wildlife Service inspector at Kennedy Airport in New York described their condition, "What we've been seeing is very large numbers in shipments, 1,000 or more, sometimes 2,000 box turtles going to Europe in horrible condition, kept in wet burlap sacks and cardboard boxes in their own excrement, with no food or water" (Stevens 1994). Article IV of CITES requires that the Management Authority of the export country must be satisfied that "any living specimen will be so prepared and shipped as to minimise the risk of injury, damage to health or cruel treatment." This cannot be assured under U.S. law, since no legislation exists that requires humane treatment of reptiles or amphibians in shipment. The Humane

and Healthful Transport of Mammals and Birds regulations of the Lacey Act should be expanded to include reptiles and amphibians.

Box turtles, like many land turtles and tortoises, can live very long lives, and a female box turtle typically takes a half century or more to produce just two offspring (Stevens 1994). According to Dr. Klemens, box turtles reproduce for 50 years or more, and one is said to have died at the age of 138 (Stevens 1994). This slow reproduction explains why their populations suffer immediate declines when exploited.

Trade in Radiated and Plowshare Tortoises, two of the most endangered species in the world, native to Madagascar, is discussed in the Islands chapter.

Wild Pets and Laboratory Animals: Snakes

The keeping of snakes as pets is a growing trend in the United States and elsewhere. It involves the removal of thousands of these animals from the wild, endangering many species. Some species of American snakes have become threatened by trade. The Florida Indigo Snake (*Drymarchon corais couperi*), listed as Threatened on the U.S. Endangered Species Act and a protected species throughout its range in the Southeast, can sell for $300 or more, and illegal trade has been very difficult to control. Snakes and other reptiles may be illegally captured in states protecting them, then transported to other states that allow sale of reptiles. These poached rare reptiles are also misrepresented as having been bred in captivity to avoid Lacey Act prosecutions. Many of these illegal reptiles are advertised on the Internet, where a new and huge market for reptile pets has developed, and many are sold illegally through the mail. Some pet shops sell illegally obtained reptiles, either knowingly or unknowingly. The market for rare snakes has grown to such an extent that an increasing number of species are threatened by capture.

Snakes have become prestigious status symbols for some people. Pythons and boa constrictors of various species are popular pets in spite of--or perhaps because of--their enormous size. They can reach lengths of 20 feet or more, and these large constrictors prefer live prey the size of rabbits. They present a danger to their owners and to the public, especially children, should they escape from captivity. In the summer of 1996, a 9-foot-long Burmese Python, kept as a pet by a man and his pregnant wife, was allowed to roam the house freely. The snake wrapped itself around the wife and began biting her in the back, refusing to let go even when the husband tried prying it off with a crowbar. He then called emergency 911 paramedics, who cut off its head with a hacksaw to kill it. Several cases of large constrictors, such as boas and pythons, biting adults and children have been publicized in recent years.

Wild Pets and Laboratory Animals: Frogs

A thriving trade in terrarium frogs has resulted in a worldwide market for many species of these amphibians. The world's largest frog, the Goliath Frog (*Conraura goliath*) of Central Africa, weighs 7.2 pounds and reaches a length of at least 32 inches. It is found along major rivers in dense tropical rainforests in Equatorial Guinea and southwest Cameroon (FWS 1991). Throughout its range, it is very rare and has unusual habitat requirements. It needs rapids and cascades with sandy bottoms and very clean, oxygen-rich water; deforestation has reduced this habitat (FWS 1991). Collectors have offered huge sums up to $2,500 for capture and export of Goliath Frogs--for personal pets or public exhibition. This species is listed on the U.S. Endangered Species Act as Threatened and protected from export in most of its range. Yet unscrupulous dealers capture them and ship them to collectors under false documentation. The Fish and Wildlife Service Law Enforcement Division conducted an undercover investigation in which an English animal dealer in Cameroon shipped 10 Goliath Frogs to California with false documents. Nine arrived dead, and a California judge sent the dealer to jail for 70 days. The trade in live frogs, which have extremely high death rates in

transport, extends to rare poison dart frogs of South America and threatened frogs of Madagascar (see Islands chapter). Wealthy collectors are willing to pay high prices for these amphibians. This destructive and unnecessary trade is now growing, threatening more species each year.

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Trade Effects Draft
The figures below represent estimates based on the sources cited.

Species	Northern Hemisphere		Southern Hemisphere		Totals		
	Original	Present	Original	Present	Original	Present	% Change
Blue ***Balaenoptera musculus***	20,100	4,300	200,000	10,000	220,100	14,300	- 94%
Bowhead ***Balaena mysticetus***	43,000	7,850	Not Present		43,000	7,850	-82%
Fin ***Balaenoptera physalus***	95,000	63,000	600,000	15,000	695,000	78,000	-89%
Gray ***Eschrictius robustus***	45,000*	22,000	Not Present		45,000	22,000	-51%
Humpback ***Megaptera novaeangliae***	50,000	8,000	100,000	20,000	150,000	28,000	-81%

Right ***Eubalaena glacialis*** ***Eubalaena autralis***	100,000	600	200,000	3,000	300,000	3,600	-99%
Sei ***Balaenoptera borealis***	400,000	21,100	190,000	8,300	590,000	29,400	-95%
Sperm ***Physeter catodon***	1,500,000	103,000	1,500,000	128,000	3,000,000	231,000	-92%
Totals	2,253,100	229,850	2,790,000	184,300	5,043,100	414,150	-61%

Hemisphere Totals			
	Original	**Present**	**Change**
Northern	2,253,100	229,850	-90%
Southern	2,790,000	184,300	-93%
Totals	5,043,100	414,150	-92%

***Includes estimations of extinct populations of Atlantic and western Pacific** Sources: *Walker's Mammals of the World*, by Ronald M. Nowak, Sixth Edition, Vol. II, Johns Hopkins University Press, 1999, which assesses various sources & research by the Animal Welfare Institute.

Endangered Species Handbook

Legislation:

- The Endangered Species Act
- CITES
- Marine Mammal Protection Act
- Lacey Act - Feather Trade
- Humane and Healthful Transport Regulations
- African Elephant Conservation Act
- Migratory Bird Treaty Act
- Eagle Protection Act
- Wild Bird Conservation Act
- NAFTA and WTO
- References

chapters AWI search

Legislation

The Endangered Species Act

Legislation mandating a list of rare and endangered species was first enacted by Congress in 1966. The Endangered Species Act (ESA) was amended in 1969 when foreign species were added to the list. In 1973, a comprehensive model Act replaced the latter act, providing the most extensive safeguards of any legislation in the world to protect declining species.

The ESA prohibits harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing and collecting listed species, unless specifically permitted, or attempting to engage in such activities within the United States or its territorial seas. Taking on the high seas is also prohibited, as are possessing, selling, delivering, carrying, transporting or shipping any species unlawfully taken within the United States, its territorial seas or on the high seas. It is also unlawful to deliver, receive, carry, transport or ship in interstate or foreign commerce in the course of commercial activity listed species, or to sell or offer listed species for sale in interstate or foreign commerce. The prohibitions apply to listed species, live and dead, their parts, and products made from their parts.

Species are listed in two categories: Endangered and Threatened. Endangered is defined as any species which is in danger of extinction throughout all--or a significant portion--of its range. Prohibitions on activities that affect species may be less strict for animals listed in the Threatened category, but these are regulated by the U.S. Fish and Wildlife Service (USFWS) on a species-by-species basis. The ESA also allows listing species similar in appearance to those that are Endangered or Threatened, when doing so would provide additional protection for the listed species.

Stiff penalties may be imposed for violations of the Endangered Species Act. Felonies may be punished with fines up to $50,000 and/or one year imprisonment for crimes involving endangered species, and $25,000 and/or six months imprisonment for crimes involving threatened species. Misdemeanors or civil penalties are punishable by fines up to $25,000 for crimes involving endangered species and $12,000 for crimes involving threatened species. A maximum of $1,000 can be assessed for unintentional violations. Rewards of up to $2,500 are paid for information leading to convictions.

The ESA has been extremely effective in saving wildlife and plant species in danger of extinction. Contrary to some who have claimed that the Endangered Species Act has interfered with government and private projects, there have been very few conflicts, and on the whole, these have been resolved to the satisfaction of both parties. The Northern Spotted Owl controversy was resolved by government retraining of loggers and an increase in high technology jobs that more than compensated for jobs lost. Other arrangements have been made with paper companies to protect the endangered Red-cockaded
Woodpecker and, in southern California, with developers to protect the Coachella Fringe-toed Lizard. As of August 2001, the USFWS had issued 500 permits for 360 "Habitat Conservation Plans.fl Many involve financial benefit to landowners. If landowners donate land where endangered species are found to a nonprofit organization or the federal government, the transaction is tax-deductible. In spite of economic interests who wish to weaken the ESA, the majority of Americans support the law and protection of endangered species (see Vanishing Species chapter).

As of July 31, 2001, the Act listed 1,802 species of animals and plants as Endangered or Threatened. Of these, a total of 507 animal and plant species were native to the United States. The Act has been instrumental in saving native species, including endangered species such as the California condor, the Black-footed Ferret and the Bald Eagle, and Threatened species such as the Northern Spotted Owl. Programs of habitat protection, captive breeding, and other means of aiding in the recovery of listed species have prevented the extinction of hundreds of plant and animal species, many little known to the American public. The Hawaiian Islands have the largest number of listed species as a result of the destruction of native ecosystems and species by introduced animals and diseases, and clearing of forests

for agriculture and ranching.

The Endangered Species Act has also been important in regulating the importation and exportation of exotic species listed. Foreign species listed totaled 555 animal and three plant species on July 31, 2001. These species include Leopards; Tigers; all species of rhinoceros; the great whales; the Andean Condor; Harpy Eagle; Imperial Parrot, among many other parrot species; Resplendent Quetzal; all sea turtles; numerous endangered tortoises; endangered caiman and crocodiles; iguanas; and fish, as well as seven endangered foreign invertebrates. Mammals comprise the majority of foreign species--251 Endangered and 17 Threatened (compared with only 63 Endangered and 9 Threatened U.S. species). These listings have prevented importation of many endangered species and their products. Prior to importation of any listed species, or part thereof, a permit must be obtained from the USFWS. Permits are not granted for commercial exploitation of non-captive-bred endangered species. Commercial importation of Leopard, Tiger or Ocelot skins, for example, is not allowed under the ESA. In spite of the severe penalties that can be exacted under the law, including jail sentences, illegal imports continue, and thousands are confiscated by USFWS agents each year. Many are tourist purchases, such as stuffed sea turtles, fur coats, and taxidermy specimens. Others are commercial items, such as reptile skins and, recently, products for the Asian medicine trade--Tiger bones and powdered rhinoceros horn.

For zoos, importation of live wild-caught specimens of endangered species requires ESA permits. If the species is listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which lists many of the same species on Appendix I (the category for species threatened with extinction), both import permits from the U.S. CITES authorities and export permits from foreign CITES authorities are required. The USFWS has required rigid proof that importation of listed species would not result in declines in wild populations of that species, except for emergency situations where wild populations are under extreme threats such as uncontrolled poaching or habitat destruction. The combined burden of proof needed for ESA and CITES has been essential in preventing needless removal from the wild of endangered species. With the proliferation of wild animal parks, small zoos, and animals used in entertainment, the pressure to weaken the ESA to allow importation of endangered species has increased. One wildlife dealer wrote an editorial in a trade journal, *Pet Business* (March 1995), that encouraged weakening the ESA: "There is no logical reason for our government to pay hundreds of thousands of dollars, if not millions, a year to control non-indigenous endangered species." Without strict regulations under the ESA, however, the Act will lose its value in preventing commercialism of endangered species around the world.

Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Endangered Species Act of 1973 also implements the provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, known as CITES. The purpose of CITES is to prevent international trade from contributing to the endangerment of any species. To achieve this, CITES establishes a system of trade controls that vary in their restrictiveness, depending upon the degree of jeopardy each species faces. The trade controls imposed by CITES apply only to the species listed on three Appendices to the Treaty. The species listed on Appendix I of the Treaty receive the most protection; they cannot be imported or exported for primarily commercial purposes. To be traded for other purposes, such as zoological or scientific imports, a specimen of any species listed in Appendix I must be accompanied by an export permit from the exporting country and an import permit from the importing country.

Species on Appendix II of CITES, which are the vast majority of all species protected by the Treaty, can be traded for both commercial and noncommercial purposes. However, they must be accompanied by an export permit, which may be issued only upon the finding that the export of the specimens concerned will not be detrimental to the survival of the species. This requirement allows countries to control trade in those species listed on Appendix II.

Member countries may unilaterally list species on Appendix III that are protected within the countries' borders. The purpose of Appendix III is to obtain international cooperation in the enforcement of national conservation laws. Countries importing specimens of a species listed on Appendix III--from the country responsible for including the species on the Appendix--must insist upon presentation of a permit showing that the specimens were lawfully acquired and exported from that country.

Marine Mammal Protection Act

Prior to passage of the Marine Mammal Protection Act (MMPA), millions of dolphins were drowned in purse seine nets set for tuna. The MMPA, enacted in 1972, established a moratorium on the taking and importation of marine mammals except under permit. The authority for protecting these animals is divided between two departments. The U.S. Department of the Interior™s Fish and Wildlife Service (USFWS) is responsible for management authority for the Sea Otter, Walrus, Polar Bear and Dugong, among others; while the U.S. Department of Commerce™s National Marine Fisheries Service (NMFS) has authority over cetaceans and seals. Under the MMPA, it is unlawful to harass, hunt, capture or kill any marine mammal on the high seas, in water or on lands under the jurisdiction of the United States except under permit.

The MMPA requires a permit prior to capturing marine mammals in all waters worldwide for public display or scientific research. These permits are issued by the USFWS or the NMFS under strict regulations. Once in captivity, the animals are under the jurisdiction of the Animal Welfare Act, which is enforced by the U.S. Department of Agriculture (USDA). Fishing vessels must apply for permits if their operations result in incidental kills; permits can be issued only if the killing, such as drowning in fishing nets, would not cause declines in wild populations below fipotential biological removal levels,fl defined as the largest number that can be killed in optimum sustainable populations. This means that populations of a particular area, such as the California Sea Lions, are used as a basis for permits, not the species™ overall population. The funding for Observers on fishing boats to verify the reports of numbers of seals, sea lions and cetaceans drowned in nets is not great enough to require Observers on all fishing boats. In general, NMFS has stated that reports of mortalities on boats without Observers total in the hundreds, but when Observers are present, thousands of marine mammals are documented as drowned. The influence of the fishing industry on issuance of these permits and formulation of regulations by the U.S. Congress has been significant. Between 1988 and 1994, all regulations on incidental kills were suspended prior to the development of present regulations under Sections 117 and 118, allowing the deaths of untold numbers of marine mammals. The present rules are far less stringent and allow higher mortality of whales, such as Humpback Whales, in ground fisheries. Regional Advisory Commissions assess each fishery to determine methods of reducing mortality. Fishing lines, nets and other apparatus have been responsible for the deaths of many endangered Northern Right Whales along Atlantic coasts in recent years, and far more regulations are needed under both the MMPA and the ESA to prevent these deaths.

Importation and exportation of marine mammals is regulated by permit as well, and very few wild marine mammals have been allowed to be imported or exported under the MMPA. In addition, the MMPA prohibits the use of any port or harbor under U.S. jurisdiction for any purpose connected with the unlawful taking or importation of any marine mammal. It is prohibited to possess any unlawfully taken marine mammal, including parts or products, and it is prohibited to transport, purchase, sell, or offer to purchase or sell any marine mammal, including parts and products. Unfortunately, the importation of Polar Bear trophies from Canada has become easier through weakening of the MMPA. The Safari Club International, a powerful trophy hunting lobby, was successful in obtaining the latter weakening of the MMPA.

Lacey Act - Feather Trade

The fashion of wearing bird feathers in women™s hats began in the court of Louis XVI of France when Marie Antoinette appeared in a headdress with feather plumes (Doughty 1975). The fashion gradually spread in Europe and later in the colonies of the United States. By 1850, the business of killing birds for the millinery trade was practiced on a large scale, involving the deaths of hundreds of thousands of birds in many parts of the world. Egrets were a prime target, especially birds in breeding plumage when their most elegant plumage was displayed. Hunters killed adult birds, leaving the chicks to die in the scorching sun. Sometimes feathers were pulled from wounded birds, which were left to die of exposure or starvation. Herons and other wading birds along the east coast and in the Everglades were slaughtered in huge numbers. Songbirds were also popular, and entire birds were stuffed and exhibited on the hats of Victorian women. The plumage of terns and gulls was commonly used, and entire breeding colonies numbering more than 10,000 birds were killed. One New York woman negotiated in 1884 with a Parisian millinery to deliver 40,000 or more bird skins; she hired gunners to kill as many terns as possible at ten cents a skin (Doughty 1975).

In order to stop this disastrous trade, as well as the trafficking in wild deer and other animals for the meat trade, the Lacey Act was passed in 1900. The Lacey Act enhanced existing laws by prohibiting interstate commerce in wildlife protected by state statute. Fines of $500 for "knowingly" transporting wildlife or products protected in another state, and $200 for "knowingly" receiving such articles, were at first assessed. Many states had protected their native birds from the feather slaughters and banned the sale of feathers, but bird hunters would transport the feathers to states where the birds were not native to sell them. The Lacey Act prohibited this interstate commerce in protected species. If, for example, egrets protected from killing by Alabama law were shot and their feathers shipped across state lines to New York, a Lacey Act violation would have been committed. The Act ended most of the commercial plume trade in Native American birds. The failure of some states to enact laws to protect their wildlife kept the Act from being 100 percent effective. The Migratory Bird Treaty Act of 1918 closed these loopholes by protecting all native migratory birds.

The Lacey Act prohibits the import, export, transportation, sale, receipt, acquisition or purchase of fish, wildlife or plants that are taken, possessed, transported or sold in violation of any federal, state, tribal or foreign law. By the turn of the century, the feather trade had nearly eliminated egrets in the United States, and populations of numerous other bird species were approaching extinction. The National Audubon Society employed guards to protect the few remaining colonies in remote parts of Florida. Three of the wardens lost their lives protecting the birds, and if the Lacey Act of 1900 and accompanying state laws had not been enacted, many species of birds would almost certainly have become extinct.

One of the first violations of the Act involved feather merchants. On Laysan Island in the Pacific, a shocking slaughter occurred. Hundreds of thousands of Laysan and Black-footed Albatross nested on this 2-mile-long island west of Hawaii. In 1909, a feather merchant hired 23 Japanese laborers to kill the nesting birds, which are tame and unwilling to leave their nests, even when attacked. Clumsy on land, the albatross need to run with wings spread, allowing the wind to buoy them before they can take flight. This makes them helpless in the face of men striking them with sticks and bats. During several months, 300,000 sea birds were killed, mainly to obtain their wings. The wings were cut off the living birds, leaving them to bleed to death; others were herded into a dry cistern and kept by the hundreds to starve to death in order to use up the fatty tissue next to the skin so that little or no cleaning was required to prepare the feathered skin (Hornaday 1913). A zoology professor from the College of Honolulu heard of this slaughter and wired federal authorities in Washington, since the island was part of U.S. territory, and the birds were protected. The merchants planned to take the bird feathers and wings to the Orient to sell. The Secretary of the Navy dispatched a cutter to Laysan, finding the carcasses, bones and three carloads of wings, feathers and skins. The

poachers were arrested and taken to Honolulu for trial (Hornaday 1913). The same year, President Theodore Roosevelt issued an Executive Order creating the Hawaiian Islands Reservation for Birds, including Laysan Island, which is now a national wildlife refuge. Unfortunately, the same feather merchant who committed the albatross slaughter, introduced rabbits to the island, which stripped the vegetation. The Laysan Rail later became extinct as a result of the rabbits and predation by rats introduced in the 1940s. The albatross have slowly recovered but, being long-lived and slow-reproducing, they are extremely vulnerable to any losses in their populations.

The feather merchants fought state laws banning killing of migratory birds after passage of the Lacey Act, especially in East Coast cities, where the millinery trade was headquartered. The Millinery Association lobbied for the repeal of a New York law banning sale of native bird feathers and brought many witnesses to Albany to prove that enforcement of the law would cause thousands of people to lose their jobs (Hornaday 1913). In 1911, the New York State Legislature refused to repeal this law. The millinery workers did not, in fact, lose their jobs; hat decorations were merely changed from feathers to silk, ribbons and lace (Hornaday 1913).

The problem remained, however, as exotic birds continued to be slaughtered for the millinery trade. Plume hunters combed the marshes of Central America, killed entire rookeries of egrets and herons, netted thousands of tiny hummingbirds in Brazil, and killed rare birds of paradise in New Guinea, and even Andean Condors in South America. In 1911, the feathers of 129,000 egrets; 13,598 herons; 20,698 birds of paradise; 41,090 hummingbirds; 9,464 eagles, condors and other birds of prey; and 9,472 other birds were sold at auction in London for the millinery trade (Hornaday 1913). The scope of the Lacey Act was later enlarged to cover foreign species.

The Lacey Act applies to all wildlife, and the once rampant trade in deer, elk and other game species killed for the restaurant trade was also severely curtailed. More recently, the Lacey Act stopped much of the illegal killing of American Alligators for the reptile products trade prior to the passage of the Endangered Species Act. Sale of alligator skins in the Northeast from alligators killed illegally in the Everglades, for example, was a Lacey Act violation if the source of the skins could be proven.

Amendments to the Act in 1981, which provided, among other things, the authority for warrantless search and seizure when violations are suspected, were designed to: 1) strengthen federal enforcement of laws to protect wildlife; and 2) improve relevant federal assistance to states and foreign governments. The Act is used to control the smuggling of and trade in illegally taken wildlife. Amendments raised maximum penalties under the Lacey Act to sentences of up to one year in jail and/or fines of up to $100,000 for misdemeanors, and five years imprisonment and/or fines up to $250,000 for felonies. Maximum fines for organizations in violation of the Lacey Act are $200,000 for misdemeanor violations and $500,000 for felonies. In addition, vehicles, aircraft, and equipment used in a violation, as well as illegally obtained fish, wildlife, and plants, may be subject to forfeiture. Persons who provide information on violations of the Lacey Act may be eligible for cash rewards.

Humane and Healthful Transport Regulations

The Humane and Healthful Transport of Wild Mammals and Birds into the United States are regulations authorized by Congress in 1981 under the Lacey Act. These regulations are extremely important in curtailing the high mortality and inhumane treatment animals receive on importation into the United States. Between 1980 and 1991, 348,318 cage birds arrived dead at U.S. ports of entry, according to USDA records. In some cases, entire shipments of birds had been so poorly crated, fed, and watered, that most of the birds were dead on arrival. CITES, to which the United States is a Party, requires that "any living specimen will be so prepared and shipped as to minimize the risk of injury, damage to health or cruel treatment."

Until the United States finalized its humane transport regulations, little could be done to stop these high-mortality

shipments, either under the Live Animal Regulations of the International Air Transport Association, which are approved by CITES, or existing regulations of the Lacey Act, which were vaguely written. The first version of the humane transport regulations was finalized in 1987, but the USFWS decided to delay the effective date for six months. The Animal Welfare Institute and 10 other animal protective organizations filed suit in U.S. District Court in March 1988 and succeeded in obtaining an injunction requiring the USFWS to enforce the regulations immediately. Later in 1988, the Service began work to modify the regulations, which were not finalized until June 1992. Thus, a delay of 11 years took place between Congress' mandate to formulate these regulations and the finalization. The final regulations require spacious cages, adequate food and water, frequent inspection during airline flights for both birds and mammals, and other safeguards to prevent mortality. In 1993, numerous violations of these regulations resulted in court cases and high fines. Most of the violations involved crowding too many birds in each crate. Present regulations allow 25 psittacine birds per crate and 50 non-psittacine perching birds, and many importers attempt to flout the regulations.

African Elephant Conservation Act

The purpose of this Act, passed in 1988, is to provide additional protection for the African Elephant. The Act established an assistance program to the countries of Africa where Elephants are indigenous and provided for the establishment of an African Elephant Conservation Fund. In addition, the Act placed a moratorium on the importation of raw or worked ivory from African countries. The ban on U.S. imports was crucial in cutting off a major market in ivory and led the way to the listing of this species on Appendix I of CITES, which ended the legal trade worldwide in 1989.

Migratory Bird Treaty Act

Signed in 1918, the Migratory Bird Treaty Act (MBTA) between Great Britain on behalf of Canada and the United States prohibited the killing of non-game migratory birds. This Treaty represented decades of effort by conservationists attempting to stop the slaughter of native birds for sale in meat markets and the millinery trade. A patchwork of state laws, bolstered by the Lacey Act of 1900, had not been entirely successful in stopping the sale of protected wildlife, especially birds, in the United States. In addition, it was recognized that many of the birds killed in the United States were Canadian in origin. The continent's birds do not recognize national boundaries. Moreover, many species migrate between North America, Russia and Japan. Others winter in, or migrate through, Mexico. In 1936, Mexico became a signatory; in 1976, the Soviet Union; and in 1972, Japan. Sea birds and birds of prey were added to the MBTA in 1972 in a signed agreement with Mexico. All these Treaties are implemented under the Act. Except for those birds hunted during seasons established by the U.S. Secretary of the Interior, all migratory birds are protected by law from killing, capture, possession and sale. The USFWS, through its Law Enforcement Division, has interpreted the MBTA strictly.

Some 65 species of birds can be legally hunted in the United States under regulations promulgated annually by the Department of the Interior. These birds include most species of ducks, geese, swans, wild pigeons, doves, Sandhill Cranes, American Woodcock, grouse, crows, Wild Turkey and quail.

For the majority of the estimated 800 species of birds breeding in North America, the MBTA has allowed recovery from the disastrous free-for-all market hunting of the 19th and early 20th centuries that caused the extinctions of the Labrador Duck, Great Auk, Passenger Pigeon, Eskimo Curlew and Heath Hen, and the near extinction of many others. The Act also prohibits the capture of live birds for the cage bird trade. It is not legal to trap Cardinals, American Robins, Blue Jays or other songbirds, either for use as personal pets or for sale in pet stores. While most

Americans are aware of the protection of their native birds, an increasing number of problems have arisen involving immigrants from countries where birds are not protected. While knowledge of the U.S. Constitution and many aspects of U.S. history are required for citizenship exams, little or no knowledge of laws relating to wildlife and natural resources is required, nor is such information given to newly arrived immigrants.

The regulations prohibit, except as allowed under specific conditions,
the taking, possession, purchase, sale, or bartering of any migratory bird, including the feathers or other parts, nests, eggs or migratory bird products. "Taking" is defined as pursuing, hunting, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, or collecting migratory birds. Migratory bird hunting regulations established by the USFWS allow, during designated seasons, the taking of ducks, geese, doves, rai, woodcock and some other species. In addition, permits may be granted for various noncommercial activities involving birds bred in captivity. Individuals and organizations may be fined up to $5,000 and $10,000 respectively, and those convicted may face up to six months imprisonment for misdemeanor violations of the Act. Felony violations may result in fines of up to $25,000 for individuals and $500,000 for organizations and up to two years imprisonment for those convicted.

For the future, binding treaties with Latin American and Caribbean nations would protect North American birds wintering in those countries. This would be especially important in view of the decline in many of the continent's songbirds and shorebirds, partly attributable to deforestation on the birds' wintering grounds. In some Latin American countries, North American shorebirds are hunted for food.

Eagle Protection Act

Passed in 1940, this Act makes it illegal to import, export, or take Bald or Golden Eagles or to sell, purchase, or barter parts, nests, eggs or products made from the animals. "Taking" encompasses pursuing, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing. Permits may be granted for scientific, exhibitory, or Indian religious purposes. However, no permits may be issued for the import, export, or commercialization of eagles. Misdemeanor violations may result in fines of up to $100,000 for individuals and $200,000 for organizations, and one year imprisonment. For felony violations, fines of up to $250,000 and $500,000 for individuals and organizations, respectively, and two years imprisonment may result. Persons providing information leading to the conviction of violators of the Eagle Protection Act may be eligible for cash rewards.

This legislation provides additional protection for the nation's two native eagle species, beyond the protection offered by the Migratory Bird Treaty Act and, in the case of the Bald Eagle, the Endangered Species Act. Numerous prosecutions have taken place of persons poisoning, shooting and otherwise harming these birds. Many sheep ranchers in the West, wrongly convinced that Golden Eagles are predators of lambs, have poisoned and shot hundreds of these birds. Bald Eagles have been shot for an active trade in Indian artifacts, such as feather headdresses. The Bald Eagle has been proposed for removal from the Endangered Species Act even though its populations remain at a fraction of original numbers and mortality in some areas is high. Should the Bald Eagle be removed from the Endangered Species Act, the Eagle Protection Act will remain a strong protection.

Wild Bird Conservation Act

The Wild Bird Conservation Act (WBCA) of 1992 is an extremely important law restricting the massive importation of wild birds into the United States for the cage bird trade. This law bans the importation into the United States of the majority of wild-caught birds. All species listed on the various appendices of CITES were banned from commercial importation one year after passage of the law. This effectively banned importation of wild parrots,

hummingbirds, birds of prey and many other birds on CITES. Regulations allow importation of birds for captive breeding under permit, and exempt species that are available only as captive-bred birds, such as canaries, cockatiels and budgerigars. Importation of birds bred in foreign countries is regulated. Zoos are exempt from the law's provisions, except that they must obtain permits for imports and provide documentation on species to be imported. The USFWS issues permits for all imported birds not specifically exempted or unlisted by CITES. The net result of the passage of this bill has been a drastic reduction in bird imports. (For more information on this law, see the Trade chapter.)

NAFTA and WTO

Two major trade treaties have been enacted that affect wildlife and the environment: the North American Free Trade Agreement (NAFTA) and the World Trade Organization, formed from the General Agreement on Tariffs and Trade (GATT). These international treaties establish panels to adjudicate conflicts over trade involving domestic legislation. NAFTA is a trade agreement negotiated with Canada and Mexico that, in principle, is intended to create a free market similar to the European Economic Union. GATT is a worldwide treaty that also encourages free trade, but through its World Trade Organization (WTO), a legal panel, it can require countries whose domestic legislation interferes with free trade to pay high fines, change the law or face retaliatory trade sanctions by other GATT nations. In 1991, for example, the Director-General of GATT appointed a panel to mediate a trade dispute between Mexico and the United States concerning the U.S. embargo on tuna products caught by setting lethal purse seine nets, which catch dolphins and drown untold thousands of these intelligent mammals. The Panel found that the Marine Mammal Protection Act was inconsistent with the treaty because domestic legislation could not interfere with free trade, a major component of this treaty. Since this was prior to the participation of the United States in WTO, U.S. government officials, after heavy lobbying from animal protection and environmental organizations, chose to block adoption of the Panel ruling. Now that the United States is a member of WTO, the Panel's decisions will have to be adhered to.

It is conceivable that the Marine Mammal Protection Act, along with the Endangered Species Act, the Lacey Act, and other laws affecting the environment, might be seriously weakened if rulings by the WTO determine aspects of these laws to be anti-free trade. For example, the WTO ruled against the United States in a case involving the importation of shrimp from countries that did not use nets designed to exclude sea turtles to prevent their drowning. U.S. laws allow such an embargo, but WTO decided this regulation was against the principles of free trade and ordered the United States to change its laws to allow shrimp to enter no matter how it was caught. WTO and NAFTA threaten U.S. sovereignty and may negate important legislation protecting wildlife and the environment, opening up trade in endangered, threatened and mistreated animals.

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Legislation

http://www.endangeredspecieshandbook.org/legislation_lacey.php

The Endangered Species Act

Legislation mandating a list of rare and endangered species was first enacted by Congress in 1966. The Endangered Species Act (ESA) was amended in 1969 when foreign species were added to the list. In 1973, a comprehensive model Act replaced the latter act, providing the most extensive safeguards of any legislation in the world to protect declining species.

The ESA prohibits harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing and collecting listed species, unless specifically permitted, or attempting to engage in such activities within the United States or its territorial seas. Taking on the high seas is also prohibited, as are possessing, selling, delivering, carrying, transporting or shipping any species unlawfully taken within the United States, its territorial seas or on the high seas. It is also unlawful to deliver, receive, carry, transport or ship in interstate or foreign commerce in the course of commercial activity listed species, or to sell or offer listed species for sale in interstate or foreign commerce. The prohibitions apply to listed species, live and dead, their parts, and products made from their parts.

Species are listed in two categories: Endangered and Threatened. Endangered is defined as any species which is in danger of extinction throughout all--or a significant portion--of its range. Prohibitions on activities that affect species may be less strict for animals listed in the Threatened category, but these are regulated by the U.S. Fish and Wildlife Service (USFWS) on a species-by-species basis. The ESA also allows listing species similar in appearance to those that are Endangered or Threatened, when doing so would provide additional protection for the listed species.

Stiff penalties may be imposed for violations of the Endangered Species Act. Felonies may be punished with fines up to $50,000 and/or one year imprisonment for crimes involving endangered species, and $25,000 and/or six months imprisonment for crimes involving threatened species. Misdemeanors or civil penalties are punishable by fines up to $25,000 for crimes involving endangered species and $12,000 for crimes involving threatened species. A maximum of $1,000 can be assessed for unintentional violations. Rewards of up to $2,500 are paid for information leading to convictions.

The ESA has been extremely effective in saving wildlife and plant species in danger of extinction. Contrary to some who have claimed that the Endangered Species Act has interfered with government and private projects, there have been very few conflicts, and on the whole, these have been resolved to the satisfaction of both parties. The Northern Spotted Owl controversy was resolved by government retraining of loggers and an increase in high technology jobs that more than compensated for jobs lost. Other arrangements have been made with paper companies to protect the endangered Red-cockaded
Woodpecker and, in southern California, with developers to protect the Coachella Fringe-toed Lizard. As of August 2001, the USFWS had issued 500 permits for 360 "Habitat Conservation Plans.fl Many involve financial benefit to landowners. If landowners donate land where endangered species are found to a nonprofit organization or the federal government, the transaction is tax-deductible. In spite of economic interests who wish to weaken the ESA, the majority of Americans support the law and protection of endangered species (see Vanishing Species chapter).

As of July 31, 2001, the Act listed 1,802 species of animals and plants as Endangered or Threatened. Of these, a total of 507 animal and plant species were native to the United States. The Act has been instrumental in saving native species, including endangered species such as the California condor, the Black-footed Ferret and the Bald Eagle, and Threatened species such as the Northern Spotted Owl. Programs of habitat protection, captive breeding, and other means of aiding in the recovery of listed species have prevented the extinction of hundreds of plant and animal species, many little known to the American public. The Hawaiian Islands have the largest number of listed species as a result of the destruction of native ecosystems and species by introduced animals and diseases, and clearing of forests

for agriculture and ranching.

The Endangered Species Act has also been important in regulating the importation and exportation of exotic species listed. Foreign species listed totaled 555 animal and three plant species on July 31, 2001. These species include Leopards; Tigers; all species of rhinoceros; the great whales; the Andean Condor; Harpy Eagle; Imperial Parrot, among many other parrot species; Resplendent Quetzal; all sea turtles; numerous endangered tortoises; endangered caiman and crocodiles; iguanas; and fish, as well as seven endangered foreign invertebrates. Mammals comprise the majority of foreign species--251 Endangered and 17 Threatened (compared with only 63 Endangered and 9 Threatened U.S. species). These listings have prevented importation of many endangered species and their products. Prior to importation of any listed species, or part thereof, a permit must be obtained from the USFWS. Permits are not granted for commercial exploitation of non-captive-bred endangered species. Commercial importation of Leopard, Tiger or Ocelot skins, for example, is not allowed under the ESA. In spite of the severe penalties that can be exacted under the law, including jail sentences, illegal imports continue, and thousands are confiscated by USFWS agents each year. Many are tourist purchases, such as stuffed sea turtles, fur coats, and taxidermy specimens. Others are commercial items, such as reptile skins and, recently, products for the Asian medicine trade--Tiger bones and powdered rhinoceros horn.

For zoos, importation of live wild-caught specimens of endangered species requires ESA permits. If the species is listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which lists many of the same species on Appendix I (the category for species threatened with extinction), both import permits from the U.S. CITES authorities and export permits from foreign CITES authorities are required. The USFWS has required rigid proof that importation of listed species would not result in declines in wild populations of that species, except for emergency situations where wild populations are under extreme threats such as uncontrolled poaching or habitat destruction. The combined burden of proof needed for ESA and CITES has been essential in preventing needless removal from the wild of endangered species. With the proliferation of wild animal parks, small zoos, and animals used in entertainment, the pressure to weaken the ESA to allow importation of endangered species has increased. One wildlife dealer wrote an editorial in a trade journal, *Pet Business* (March 1995), that encouraged weakening the ESA: "There is no logical reason for our government to pay hundreds of thousands of dollars, if not millions, a year to control non-indigenous endangered species." Without strict regulations under the ESA, however, the Act will lose its value in preventing commercialism of endangered species around the world.

Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Endangered Species Act of 1973 also implements the provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, known as CITES. The purpose of CITES is to prevent international trade from contributing to the endangerment of any species. To achieve this, CITES establishes a system of trade controls that vary in their restrictiveness, depending upon the degree of jeopardy each species faces. The trade controls imposed by CITES apply only to the species listed on three Appendices to the Treaty. The species listed on Appendix I of the Treaty receive the most protection; they cannot be imported or exported for primarily commercial purposes. To be traded for other purposes, such as zoological or scientific imports, a specimen of any species listed in Appendix I must be accompanied by an export permit from the exporting country and an import permit from the importing country.

Species on Appendix II of CITES, which are the vast majority of all species protected by the Treaty, can be traded for both commercial and noncommercial purposes. However, they must be accompanied by an export permit, which may be issued only upon the finding that the export of the specimens concerned will not be detrimental to the survival of the species. This requirement allows countries to control trade in those species listed on Appendix II.

Member countries may unilaterally list species on Appendix III that are protected within the countries' borders. The purpose of Appendix III is to obtain international cooperation in the enforcement of national conservation laws. Countries importing specimens of a species listed on Appendix III--from the country responsible for including the species on the Appendix--must insist upon presentation of a permit showing that the specimens were lawfully acquired and exported from that country.

Marine Mammal Protection Act

Prior to passage of the Marine Mammal Protection Act (MMPA), millions of dolphins were drowned in purse seine nets set for tuna. The MMPA, enacted in 1972, established a moratorium on the taking and importation of marine mammals except under permit. The authority for protecting these animals is divided between two departments. The U.S. Department of the Interior™s Fish and Wildlife Service (USFWS) is responsible for management authority for the Sea Otter, Walrus, Polar Bear and Dugong, among others; while the U.S. Department of Commerce™s National Marine Fisheries Service (NMFS) has authority over cetaceans and seals. Under the MMPA, it is unlawful to harass, hunt, capture or kill any marine mammal on the high seas, in water or on lands under the jurisdiction of the United States except under permit.

The MMPA requires a permit prior to capturing marine mammals in all waters worldwide for public display or scientific research. These permits are issued by the USFWS or the NMFS under strict regulations. Once in captivity, the animals are under the jurisdiction of the Animal Welfare Act, which is enforced by the U.S. Department of Agriculture (USDA). Fishing vessels must apply for permits if their operations result in incidental kills; permits can be issued only if the killing, such as drowning in fishing nets, would not cause declines in wild populations below fipotential biological removal levels,fl defined as the largest number that can be killed in optimum sustainable populations. This means that populations of a particular area, such as the California Sea Lions, are used as a basis for permits, not the species™ overall population. The funding for Observers on fishing boats to verify the reports of numbers of seals, sea lions and cetaceans drowned in nets is not great enough to require Observers on all fishing boats. In general, NMFS has stated that reports of mortalities on boats without Observers total in the hundreds, but when Observers are present, thousands of marine mammals are documented as drowned. The influence of the fishing industry on issuance of these permits and formulation of regulations by the U.S. Congress has been significant. Between 1988 and 1994, all regulations on incidental kills were suspended prior to the development of present regulations under Sections 117 and 118, allowing the deaths of untold numbers of marine mammals. The present rules are far less stringent and allow higher mortality of whales, such as Humpback Whales, in ground fisheries. Regional Advisory Commissions assess each fishery to determine methods of reducing mortality. Fishing lines, nets and other apparatus have been responsible for the deaths of many endangered Northern Right Whales along Atlantic coasts in recent years, and far more regulations are needed under both the MMPA and the ESA to prevent these deaths.

Importation and exportation of marine mammals is regulated by permit as well, and very few wild marine mammals have been allowed to be imported or exported under the MMPA. In addition, the MMPA prohibits the use of any port or harbor under U.S. jurisdiction for any purpose connected with the unlawful taking or importation of any marine mammal. It is prohibited to possess any unlawfully taken marine mammal, including parts or products, and it is prohibited to transport, purchase, sell, or offer to purchase or sell any marine mammal, including parts and products. Unfortunately, the importation of Polar Bear trophies from Canada has become easier through weakening of the MMPA. The Safari Club International, a powerful trophy hunting lobby, was successful in obtaining the latter weakening of the MMPA.

Lacey Act - Feather Trade

The fashion of wearing bird feathers in women™s hats began in the court of Louis XVI of France when Marie Antoinette appeared in a headdress with feather plumes (Doughty 1975). The fashion gradually spread in Europe and later in the colonies of the United States. By 1850, the business of killing birds for the millinery trade was practiced on a large scale, involving the deaths of hundreds of thousands of birds in many parts of the world. Egrets were a prime target, especially birds in breeding plumage when their most elegant plumage was displayed. Hunters killed adult birds, leaving the chicks to die in the scorching sun. Sometimes feathers were pulled from wounded birds, which were left to die of exposure or starvation. Herons and other wading birds along the east coast and in the Everglades were slaughtered in huge numbers. Songbirds were also popular, and entire birds were stuffed and exhibited on the hats of Victorian women. The plumage of terns and gulls was commonly used, and entire breeding colonies numbering more than 10,000 birds were killed. One New York woman negotiated in 1884 with a Parisian millinery to deliver 40,000 or more bird skins; she hired gunners to kill as many terns as possible at ten cents a skin (Doughty 1975).

In order to stop this disastrous trade, as well as the trafficking in wild deer and other animals for the meat trade, the Lacey Act was passed in 1900. The Lacey Act enhanced existing laws by prohibiting interstate commerce in wildlife protected by state statute. Fines of $500 for "knowingly" transporting wildlife or products protected in another state, and $200 for "knowingly" receiving such articles, were at first assessed. Many states had protected their native birds from the feather slaughters and banned the sale of feathers, but bird hunters would transport the feathers to states where the birds were not native to sell them. The Lacey Act prohibited this interstate commerce in protected species. If, for example, egrets protected from killing by Alabama law were shot and their feathers shipped across state lines to New York, a Lacey Act violation would have been committed. The Act ended most of the commercial plume trade in Native American birds. The failure of some states to enact laws to protect their wildlife kept the Act from being 100 percent effective. The Migratory Bird Treaty Act of 1918 closed these loopholes by protecting all native migratory birds.

The Lacey Act prohibits the import, export, transportation, sale, receipt, acquisition or purchase of fish, wildlife or plants that are taken, possessed, transported or sold in violation of any federal, state, tribal or foreign law. By the turn of the century, the feather trade had nearly eliminated egrets in the United States, and populations of numerous other bird species were approaching extinction. The National Audubon Society employed guards to protect the few remaining colonies in remote parts of Florida. Three of the wardens lost their lives protecting the birds, and if the Lacey Act of 1900 and accompanying state laws had not been enacted, many species of birds would almost certainly have become extinct.

One of the first violations of the Act involved feather merchants. On Laysan Island in the Pacific, a shocking slaughter occurred. Hundreds of thousands of Laysan and Black-footed Albatross nested on this 2-mile-long island west of Hawaii. In 1909, a feather merchant hired 23 Japanese laborers to kill the nesting birds, which are tame and unwilling to leave their nests, even when attacked. Clumsy on land, the albatross need to run with wings spread, allowing the wind to buoy them before they can take flight. This makes them helpless in the face of men striking them with sticks and bats. During several months, 300,000 sea birds were killed, mainly to obtain their wings. The wings were cut off the living birds, leaving them to bleed to death; others were herded into a dry cistern and kept by the hundreds to starve to death in order to use up the fatty tissue next to the skin so that little or no cleaning was required to prepare the feathered skin (Hornaday 1913). A zoology professor from the College of Honolulu heard of this slaughter and wired federal authorities in Washington, since the island was part of U.S. territory, and the birds were protected. The merchants planned to take the bird feathers and wings to the Orient to sell. The Secretary of the Navy dispatched a cutter to Laysan, finding the carcasses, bones and three carloads of wings, feathers and skins. The

poachers were arrested and taken to Honolulu for trial (Hornaday 1913). The same year, President Theodore Roosevelt issued an Executive Order creating the Hawaiian Islands Reservation for Birds, including Laysan Island, which is now a national wildlife refuge. Unfortunately, the same feather merchant who committed the albatross slaughter, introduced rabbits to the island, which stripped the vegetation. The Laysan Rail later became extinct as a result of the rabbits and predation by rats introduced in the 1940s. The albatross have slowly recovered but, being long-lived and slow-reproducing, they are extremely vulnerable to any losses in their populations.

The feather merchants fought state laws banning killing of migratory birds after passage of the Lacey Act, especially in East Coast cities, where the millinery trade was headquartered. The Millinery Association lobbied for the repeal of a New York law banning sale of native bird feathers and brought many witnesses to Albany to prove that enforcement of the law would cause thousands of people to lose their jobs (Hornaday 1913). In 1911, the New York State Legislature refused to repeal this law. The millinery workers did not, in fact, lose their jobs; hat decorations were merely changed from feathers to silk, ribbons and lace (Hornaday 1913).

The problem remained, however, as exotic birds continued to be slaughtered for the millinery trade. Plume hunters combed the marshes of Central America, killed entire rookeries of egrets and herons, netted thousands of tiny hummingbirds in Brazil, and killed rare birds of paradise in New Guinea, and even Andean Condors in South America. In 1911, the feathers of 129,000 egrets; 13,598 herons; 20,698 birds of paradise; 41,090 hummingbirds; 9,464 eagles, condors and other birds of prey; and 9,472 other birds were sold at auction in London for the millinery trade (Hornaday 1913). The scope of the Lacey Act was later enlarged to cover foreign species.

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The Humane and Healthful Transport of Wild Mammals and Birds into the United States are regulations authorized by Congress in 1981 under the Lacey Act. These regulations are extremely important in curtailing the high mortality and inhumane treatment animals receive on importation into the United States. Between 1980 and 1991, 348,318 cage birds arrived dead at U.S. ports of entry, according to USDA records. In some cases, entire shipments of birds had been so poorly crated, fed, and watered, that most of the birds were dead on arrival. CITES, to which the United States is a Party, requires that "any living specimen will be so prepared and shipped as to minimize the risk of injury, damage to health or cruel treatment."

Until the United States finalized its humane transport regulations, little could be done to stop these high-mortality

shipments, either under the Live Animal Regulations of the International Air Transport Association, which are approved by CITES, or existing regulations of the Lacey Act, which were vaguely written. The first version of the humane transport regulations was finalized in 1987, but the USFWS decided to delay the effective date for six months. The Animal Welfare Institute and 10 other animal protective organizations filed suit in U.S. District Court in March 1988 and succeeded in obtaining an injunction requiring the USFWS to enforce the regulations immediately. Later in 1988, the Service began work to modify the regulations, which were not finalized until June 1992. Thus, a delay of 11 years took place between Congress' mandate to formulate these regulations and the finalization. The final regulations require spacious cages, adequate food and water, frequent inspection during airline flights for both birds and mammals, and other safeguards to prevent mortality. In 1993, numerous violations of these regulations resulted in court cases and high fines. Most of the violations involved crowding too many birds in each crate. Present regulations allow 25 psittacine birds per crate and 50 non-psittacine perching birds, and many importers attempt to flout the regulations.

African Elephant Conservation Act

The purpose of this Act, passed in 1988, is to provide additional protection for the African Elephant. The Act established an assistance program to the countries of Africa where Elephants are indigenous and provided for the establishment of an African Elephant Conservation Fund. In addition, the Act placed a moratorium on the importation of raw or worked ivory from African countries. The ban on U.S. imports was crucial in cutting off a major market in ivory and led the way to the listing of this species on Appendix I of CITES, which ended the legal trade worldwide in 1989.

Migratory Bird Treaty Act

Signed in 1918, the Migratory Bird Treaty Act (MBTA) between Great Britain on behalf of Canada and the United States prohibited the killing of non-game migratory birds. This Treaty represented decades of effort by conservationists attempting to stop the slaughter of native birds for sale in meat markets and the millinery trade. A patchwork of state laws, bolstered by the Lacey Act of 1900, had not been entirely successful in stopping the sale of protected wildlife, especially birds, in the United States. In addition, it was recognized that many of the birds killed in the United States were Canadian in origin. The continent's birds do not recognize national boundaries. Moreover, many species migrate between North America, Russia and Japan. Others winter in, or migrate through, Mexico. In 1936, Mexico became a signatory; in 1976, the Soviet Union; and in 1972, Japan. Sea birds and birds of prey were added to the MBTA in 1972 in a signed agreement with Mexico. All these Treaties are implemented under the Act. Except for those birds hunted during seasons established by the U.S. Secretary of the Interior, all migratory birds are protected by law from killing, capture, possession and sale. The USFWS, through its Law Enforcement Division, has interpreted the MBTA strictly.

Some 65 species of birds can be legally hunted in the United States under regulations promulgated annually by the Department of the Interior. These birds include most species of ducks, geese, swans, wild pigeons, doves, Sandhill Cranes, American Woodcock, grouse, crows, Wild Turkey and quail.

For the majority of the estimated 800 species of birds breeding in North America, the MBTA has allowed recovery from the disastrous free-for-all market hunting of the 19th and early 20th centuries that caused the extinctions of the Labrador Duck, Great Auk, Passenger Pigeon, Eskimo Curlew and Heath Hen, and the near extinction of many others. The Act also prohibits the capture of live birds for the cage bird trade. It is not legal to trap Cardinals, American Robins, Blue Jays or other songbirds, either for use as personal pets or for sale in pet stores. While most

Americans are aware of the protection of their native birds, an increasing number of problems have arisen involving immigrants from countries where birds are not protected. While knowledge of the U.S. Constitution and many aspects of U.S. history are required for citizenship exams, little or no knowledge of laws relating to wildlife and natural resources is required, nor is such information given to newly arrived immigrants.

The regulations prohibit, except as allowed under specific conditions,
the taking, possession, purchase, sale, or bartering of any migratory bird, including the feathers or other parts, nests, eggs or migratory bird products. "Taking" is defined as pursuing, hunting, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, or collecting migratory birds. Migratory bird hunting regulations established by the USFWS allow, during designated seasons, the taking of ducks, geese, doves, rai, woodcock and some other species. In addition, permits may be granted for various noncommercial activities involving birds bred in captivity. Individuals and organizations may be fined up to $5,000 and $10,000 respectively, and those convicted may face up to six months imprisonment for misdemeanor violations of the Act. Felony violations may result in fines of up to $25,000 for individuals and $500,000 for organizations and up to two years imprisonment for those convicted.

For the future, binding treaties with Latin American and Caribbean nations would protect North American birds wintering in those countries. This would be especially important in view of the decline in many of the continent's songbirds and shorebirds, partly attributable to deforestation on the birds' wintering grounds. In some Latin American countries, North American shorebirds are hunted for food.

Eagle Protection Act

Passed in 1940, this Act makes it illegal to import, export, or take Bald or Golden Eagles or to sell, purchase, or barter parts, nests, eggs or products made from the animals. "Taking" encompasses pursuing, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing. Permits may be granted for scientific, exhibitory, or Indian religious purposes. However, no permits may be issued for the import, export, or commercialization of eagles. Misdemeanor violations may result in fines of up to $100,000 for individuals and $200,000 for organizations, and one year imprisonment. For felony violations, fines of up to $250,000 and $500,000 for individuals and organizations, respectively, and two years imprisonment may result. Persons providing information leading to the conviction of violators of the Eagle Protection Act may be eligible for cash rewards.

This legislation provides additional protection for the nation's two native eagle species, beyond the protection offered by the Migratory Bird Treaty Act and, in the case of the Bald Eagle, the Endangered Species Act. Numerous prosecutions have taken place of persons poisoning, shooting and otherwise harming these birds. Many sheep ranchers in the West, wrongly convinced that Golden Eagles are predators of lambs, have poisoned and shot hundreds of these birds. Bald Eagles have been shot for an active trade in Indian artifacts, such as feather headdresses. The Bald Eagle has been proposed for removal from the Endangered Species Act even though its populations remain at a fraction of original numbers and mortality in some areas is high. Should the Bald Eagle be removed from the Endangered Species Act, the Eagle Protection Act will remain a strong protection.

Wild Bird Conservation Act

The Wild Bird Conservation Act (WBCA) of 1992 is an extremely important law restricting the massive importation of wild birds into the United States for the cage bird trade. This law bans the importation into the United States of the majority of wild-caught birds. All species listed on the various appendices of CITES were banned from commercial importation one year after passage of the law. This effectively banned importation of wild parrots,

hummingbirds, birds of prey and many other birds on CITES. Regulations allow importation of birds for captive breeding under permit, and exempt species that are available only as captive-bred birds, such as canaries, cockatiels and budgerigars. Importation of birds bred in foreign countries is regulated. Zoos are exempt from the law's provisions, except that they must obtain permits for imports and provide documentation on species to be imported. The USFWS issues permits for all imported birds not specifically exempted or unlisted by CITES. The net result of the passage of this bill has been a drastic reduction in bird imports. (For more information on this law, see the Trade chapter.)

NAFTA and WTO

Two major trade treaties have been enacted that affect wildlife and the environment: the North American Free Trade Agreement (NAFTA) and the World Trade Organization, formed from the General Agreement on Tariffs and Trade (GATT). These international treaties establish panels to adjudicate conflicts over trade involving domestic legislation. NAFTA is a trade agreement negotiated with Canada and Mexico that, in principle, is intended to create a free market similar to the European Economic Union. GATT is a worldwide treaty that also encourages free trade, but through its World Trade Organization (WTO), a legal panel, it can require countries whose domestic legislation interferes with free trade to pay high fines, change the law or face retaliatory trade sanctions by other GATT nations. In 1991, for example, the Director-General of GATT appointed a panel to mediate a trade dispute between Mexico and the United States concerning the U.S. embargo on tuna products caught by setting lethal purse seine nets, which catch dolphins and drown untold thousands of these intelligent mammals. The Panel found that the Marine Mammal Protection Act was inconsistent with the treaty because domestic legislation could not interfere with free trade, a major component of this treaty. Since this was prior to the participation of the United States in WTO, U.S. government officials, after heavy lobbying from animal protection and environmental organizations, chose to block adoption of the Panel ruling. Now that the United States is a member of WTO, the Panel's decisions will have to be adhered to.

It is conceivable that the Marine Mammal Protection Act, along with the Endangered Species Act, the Lacey Act, and other laws affecting the environment, might be seriously weakened if rulings by the WTO determine aspects of these laws to be anti-free trade. For example, the WTO ruled against the United States in a case involving the importation of shrimp from countries that did not use nets designed to exclude sea turtles to prevent their drowning. U.S. laws allow such an embargo, but WTO decided this regulation was against the principles of free trade and ordered the United States to change its laws to allow shrimp to enter no matter how it was caught. WTO and NAFTA threaten U.S. sovereignty and may negate important legislation protecting wildlife and the environment, opening up trade in endangered, threatened and mistreated animals.

References

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Endangered Species Handbook

Projects:

- Profile of an Endangered Species
- Biodiversity
- Bats: Ecologically Important Mammals
- Conserving the Wood Thrush
- North America in the Year 1400
- Forests
- Grasslands
- Aquatic Ecosystems
- Trade
- Predator Prejudice
- Saving the American Elm and Chestnut Trees
- Bees and Other Pollinators
- Learning Animal Anatomy Without Dissection
- Attitudes and Ethics
- Wildlife Music
- Lawns
- Living with Nature
- Lifestyles and Citizen Action

Projects

Profile of an Endangered Species

Project Summary

Select a species threatened with extinction from the lists of endangered species in the Appendix of *The Endangered Species Handbook*, the *2000 IUCN List of Threatened Species* or another list mentioned below. Using the list of numbered information below as a guide, list its common name, scientific name and other information in that order. Not all of the questions listed below can be answered from available sources, but give an overview with as much information as possible.

Background

Species threatened with extinction may be classified in categories such as Critical, Endangered, Threatened, Vulnerable or Imperiled on various lists such as the US Endangered Species Act, the International Union for the Conservation of Nature and Natural Resources' (IUCN) *2000 Red List of Threatened Species*, publications of The Nature Conservancy or other organizations listed in the Organizations list in the Appendix. (For definitions of the US Endangered Species Act and the IUCN categories, see the list of Endangered and Threatened Species of Mammals, Birds, Reptiles and Amphibians in the Appendix.) This project seeks to describe species in decline or those on the verge of extinction. The number of plants and animals in these categories has increased in the past few decades. Of the many causes threatening species, the disappearance of wild habitats is the most important overall. But for many species, rampant trade and introductions of non-native species are the primary causes. Pollution, pesticides and other toxic chemicals, thinning of the ozone layer and other environmental problems play roles as well. For some species, several of these factors contribute to their decline.

The attitudes of people toward the environment and wildlife in areas where these species are found are often of extreme importance in deciding whether habitats are conserved, laws passed to prevent killing and trade and other conservation measures taken. In some countries, such as Bhutan in the Himalayas, wildlife is held in high regard, and heavy penalties are exacted for destroying the natural landscape or killing animals. In others, high population pressures, faltering economies and political chaos result in destruction of forests and wildlife for commercial purposes, in spite of protective laws and many concerned citizens. In the United States, the US Endangered Species Act is supported by the majority of people, but opposed by a large segment, who see it as politically and economically intrusive. Thus, the conservation status of species threatened with extinction is a complicated picture.

Legal protection, if not enforced, can leave the species open to poaching, even in protected reserves. In spite of strict laws, the Tiger, for example, has been killed in national parks and reserves throughout its range, as a result of high prices paid for its body parts in Traditional Medicine. Thus, a species must receive many types of protection, from habitat to hunting and sale restrictions, combined with a strong protective attitude by people living within its range and elsewhere. Also, funding for research and habitat protection is a major factor that is often lacking for the less charismatic species, such as invertebrates and many plants. The reports generated in this project may consist of only a page or a long report, depending on the wishes of the teacher, student or individual participating in this project.

Methods

Answering as many of the questions listed below as possible concerning an individual species selected is the purpose of the project. It might be easiest to select a native species of animal or plant on the US Endangered Species Act or listed by state Natural Heritage Programs for information that is readily available, or a species about which books or reports have been written, such as the Gray Wolf, the Tiger or the Whooping Crane. One can contact the state Natural Heritage offices in care of each state capital, the US Endangered Species Office in Washington, DC, for federally listed species or the regional offices of the US Fish and Wildfire Service. The US Fish and Wildlife Service has a website as well (see the Organizations list in the Appendix). For information on birds threatened with extinction

worldwide, *Threatened Birds of the World*, by BirdLife International, published in 2000 by Lynx Edicions, Barcelona, provides status and other background information, illustrations and references on more than 1,000 species of birds. *Mammals of the World*, by Ronald M. Nowak (1999, Sixth Edition, Johns Hopkins University Press), is another reference providing much of the information listed below. The *2000 IUCN Red List of Threatened Species*, available in CD-ROM disk and on the Internet (www.redlist.org), lists animals and plants of the world in various categories of threat along with basic background information. It is published by The Red List Programme Officer, 219c Huntingdon Road, Cambridge CB3 0DL, UK; e-mail redlist@ssc-uk.org. Additional books and articles can be found in the Books and Publications Section of the Appendix of this book and in reference lists following each chapter. Within the text of *The Endangered Species Handbook* are many case histories that might provide background information as well. Read Traits of Vulnerable Species in Chapter 2, Vanishing Species**,** to better understand the importance of many of the following questions.

Activities

Answer the following questions with the best available information.

Part I. Description and Characteristics of the Species

1. Species common name, scientific name
2. Class and Family
3. Past range: in recent years and historically
4. Present range: country or countries, region or location
   Does the species have a small breeding range, but a large wintering range?
5. Is the species endemic to a restricted area or region**,** such as an island?
6. What type of habitat does the species inhabit? (For example, oceans, undammed rivers, lakes, old-growth forests, grasslands, mixed habitat.)
7. What is the approximate size of its territory? For example, Siberian Tigers may require 500 square miles per animal, while a small gazelle might survive in an area of only a few square miles. The territorial needs of a species are crucial to its conservation.
8. Does the species require a specialized habitat or diet? Is it adaptable to a variety of habitats or diets?
9. Does the species show altruism, or the unselfish care for members of its own kind?
10. What is the species longevity, if known?
11. What is the species rate of reproduction? (How many young or seeds does it produce, at what intervals and what is their survival?)
12. What is the species rate of natural mortality? (Does the species have few natural enemies or causes of mortality or do large numbers of the species die each year?)
13. Is the species a flightless bird or slow•moving animal? How does this affect its ability to defend itself against predators--human and animal?
14. Is this a large or small animal? The term is relative and denotes size that humans consider large, such as elephants, and other large ungulates, such as antelope, giraffes or rhinoceros, as opposed to small gazelles; for predators, Tigers are large as compared to Ocelots or Margays.
15. Does the species breed in colonies or require large numbers of its own kind for protection, to locate food sources or for other means of survival?

Part B. Status and Conservation

1. Status: What are the threats to this species' survival? (For example, habitat loss, effects of exotic species, trade or other causes.) Describe them in detail.
2. Population numbers, where known, past (historic) and present. (In most cases this would be general information, such as common and widespread in the past, and small population numbers at present.)
3. Current situation: Is the species in steep decline, making its status Critical, or in gradual decline, making its status Vulnerable. Is its population stable, but threatened because of very small numbers?
4. If in decline, does the present rate of decline exceed annual recruitment by reproduction? If so, by how much?
5. Legal status: Is the species legally protected from killing, capture, sale and harm in all or a portion of its range? If a species is found in many countries, provide as much information as possible. If protected, is the protection enforced?
6. Status of habitat: Are there reserves or national parks protecting the habitat? Is the habitat being destroyed, or is land use compatible with the needs of the species?
7. What are the attitudes of most people who live in the range of the species toward it? Are they aware of its presence and status? If so, do they support its protection or are they neutral or even negative, persecuting it?
8. Adequacy of existing conservation: What is being done, either by governmental or private conservation organizations or individuals, to help the species survive? Is the present program effective? Is adequate funding available for its protection? What would be needed to better ensure its survival?
9. What are the potential threats to the species, such as future habitat destruction from expanding human settlements and government policies of land development? For example, the wildlife of India will be under increasing pressure as the population increases and wild habitat is destroyed. Government policies, such as resettlement of people or development of grassland or rivers for human use, can present major threats to wildlife. China, for example, is gradually resettling millions of people into the steppe grasslands of its far west who are having a negative effect on native wildlife and the environment. Through data in almanacs on the rate of human population growth**,** calculate the threat of habitat loss in the future.
10. Can you think of something that needs to be done for the species, such as research; publicity in the form of articles or a film about its status; increased commitment from government or organizations to its conservation; or a website on the Internet asking for more information and suggestions? Can you think of a way you or your class could help the species?

Biodiversity

Project Summary

Biodiversity is a term used to describe the numbers of species, families and other biological divisions of life forms on Earth. Studies of this subject in various parts of the world will be discussed. Certain regions and countries in the world harbor very large numbers of plant and animal species, yet these same areas are threatened by habitat destruction. What is being done to preserve such areas will be explored. The importance of preserving biodiversity to human society and environmental balance is a major purpose of the project. A related topic integral to the study of biodiversity is the variety of ecosystems and environments that provide habitats for the great diversity of life on Earth and their protection.

Background

As studies of the natural world have blossomed over the past century, scientists have documented Earth's amazing array of plants and animals, each species interrelated with others in its environment. Although life exists even in inhospitable environments, such as frigid mountain tops and hot springs, certain ecosystems, primarily tropical forests and coral reefs, harbor the greatest diversity of species. Research on the species of plants and animals in these areas is just beginning, but remarkable findings have emerged. In a single tree in Peru, for example, Dr. Edward O. Wilson, a famed biodiversity expert and entomologist, found 43 species of ants, a number equal to all the species of ants found in the British Isles.

Studies of biodiversity have increased in recent years, and one country, Costa Rica, is now carrying out a biological inventory of all its species, a massive and important task that may take a century. A study that has gone on since the building of the Panama Canal measures the decline in the number of species living on Barro Colorado Island as the waters of the Panama Canal rose around it. It has documented the loss of many wide-ranging species as the range grew smaller. Such studies add to the understanding of habitat requirements for various species and how the loss of some affects ecosystems as a whole. A study in the Brazilian Amazon measured the biodiversity of an extensive rainforest prior to cutting it into parcels of varying size to determine the effects on species (see Lovejoy *et al.* 1984). As a result of extensive deforestation, especially in tropical countries, many studies of forest fragmentation and its effects on biological diversity are taking place, finding that losses of even a few species can result in major ecological damage (see Laurance and Bierregaard 1997 and description in the Forests chapter). Biodiversity studies known as RAPs, or Rapid Assessment Programs, last only a few days and seek to identify areas of high diversity that are in danger of being destroyed. "Environmental S.W.A.T Team" is a film about biologists who conduct one of these RAPS, inventorying a tropical forest for Conservation International, an organization which was able to convince the country's government to protect a threatened region based on the results of the study (see Video section).

Brazil's Atlantic Forest, one of the world's most diverse environments, which once covered millions of square miles along the southern coast and well inland, has been reduced by 92 percent. Remnants of this forest have been found to harbor the greatest diversity of trees in the world: 476 species in a plot of only 2.5 acres. By contrast, a plot of similar size in a North American temperate forest has fewer than 80 species of trees. This is known as a "hotspot," or an area of great biological diversity. Others include forests in the Andes, Madagascar and Indonesia (see Mittermeier *et al.* 1999). A vast array of plants and animals can be found in the hot spots, including many extremely unusual and unique examples of evolution that are in imminent danger of extinction. New Caledonia, for example, an island in the southwestern Pacific Ocean, is home to a variety of plants and animals of ancient origin. It is a small portion of Gondwana, the southern supercontinent that broke up into pieces some 140 million years ago at the dawn of the age of birds. The ancestors of the most primitive avian families originated in Gondwana, and the Kagu, a bird still resident on New Caledonia, is a direct descendant (see Cracraft 2001). Related to cranes, rails and bustards, the elegant, gray Kagu is flightless, with a stunning pattern of wing and head crest feathers. It possesses characteristics so unusual that it has been placed in its own avian family. The Kagu is threatened with extinction along with scores of other ancient species on New Caledonia, many of which had survived for millions of years (see *Threatened Birds of the World*). This hotspot is in grave danger of losing diversity to nickel mining, feral dogs that kill the Kagus and other wildlife, and deforestation.

The huge growth in human population over the past century, now totaling some 6.5 billion, is responsible for colonization of previously remote wilderness areas and for providing a market for the decimation of ancient forests and rare wildlife for commercial purposes. Land is being cleared for grazing livestock and farming, while mining, industry, corporate logging and other development are obliterating species throughout the world. Forests have the largest number of threatened species of any habitat, although the oceans have scarcely been explored for biodiversity. Tropical forests throughout the world harbor about half the world's plants and animals on only 7 percent of the planet's land area. Hot spots also exist in temperate regions, such as the Appalachian mountains of the eastern United States, which have more types of salamanders than exist anywhere in the world, now threatened by pollution and logging. Rivers and waterways of the southeastern United States have the greatest number of mussel species in the world, but government dam and water projects have caused hundreds of extinctions. Grasslands, where only a century ago wild antelope, bison and other ungulates roamed in untold millions, have been converted into farms or pastureland for livestock, the wildlife killed off or driven away. In Earth's history, mass extinctions have occurred on at least five occasions, nearly obliterating the majority of life forms. These were natural events, but the present catastrophic situation is considered the sixth mass extinction, one that may end in destroying or seriously damaging the remaining rainforests, coral reefs and other precious centers of biodiversity within the next century (see Wilson 1988, Leakey and Lewin 1995). By some estimates, half of the estimated 5 million animals and plants that now exist, only a fraction of which have been scientifically identified, could be gone within a century.

Just as the diversity and ecological roles of species are beginning to be seen as components of an immense and beautiful living tapestry, the strands of this tapestry are unraveling. The disappearance of even a single species can result in extinctions of others dependent on it. For example, elephants and hornbills are the primary dispersers of many forest plant seeds, upon which a host of animals rely. Both are now in danger of extinction, threatening entire ecosystems. Thus, biodiversity is not an abstract concept, but a blueprint of the Earth's life forms. It is vital that its many parts be preserved. Once destroyed, many ecosystems, such as old-growth forests and other key environments, may never regenerate. In most such cases, our knowledge of diverse systems is inadequate to gauge just how many species--or which species--could disappear from an ecosystem before it collapses. Nor do we know how much genetic diversity a species can lose through loss of individuals before it can no longer adapt to changes in its environment. Drastic changes caused by human activities are outpacing research on such situations. The healthy functioning of ecosystems is key to human survival. Although the majority of biologists consider the loss of biodiversity to be the greatest problem facing humanity, few members of the public are even aware of this critical situation. Ignoring these experts' opinions of the precarious status of our planet's health, upon which our lives depend, is the equivalent of ignoring the opinion of a team of eminent doctors recommending urgent action to remedy an emergency medical condition.

Steps are being taken to preserve many critically important regions. Through acquisition of habitats and reintroductions of species, entire ecosystems are being saved. In a growing trend, countries are setting aside large new national parks and reserves. Suriname, for example, has established a national park that encompasses the central core of the country, covered in virgin rainforest and teeming with wildlife. Bolivia has set aside massive parks in areas with high biodiversity and unusual types of forests. Brazil, with the help of conservationists from around the world, is now working to save the last 8 percent of its Atlantic Forest in the southeast. Several countries in southern Africa are establishing international parks that greatly enlarge protected areas and allow migratory species, such as African Elephants and other ungulates, to move freely across borders. Corridors for wildlife to move from one area to another are also being established in the Americas. These prevent isolation of small populations of animals that would likely dwindle to extinction. Education is key to the future of preserving biodiversity, which is vital in maintaining the planet's ecological stability. Studies on this and related subjects are now being taught in an increasing number of high schools and colleges so that future generations will not squander the planet's true wealth, its natural heritage. Appreciation of the sheer beauty of the natural world and its wealth of species is an important facet of this project.

Activities

o **Biodiversity study.** Organize a group of students or interested persons to conduct biodiversity studies in your

area. Ecosystems should range from low to high diversity. To study forest diversity, for example, you might select: (1) a small city park; (2) a suburban back yard or tree farm, and 3. a woodland, preferably old-growth. To study aquatic ecosystems, you might select: (1) a city creek or river; (2) a suburban pond, and (3) a sizeable natural wetland. The complexity of the project will depend on the experts available for identifying and recording species. The object will be to list as many species as possible from each area and provide a general description of the habitat. If there are rare, threatened or endangered species in any of the areas, these should be described and, if seen, carefully noted. Invite employees of the state's Natural Heritage Program to help in selection of sites and, if possible, accompany the group. A biodiversity day in the Boston area attracted many scientists, including botanists, ornithologists, herpetologists and mammalogists, who educated interested members of the public at various sites. Experts in birds do not have to be ornithologists but can be proficient bird-watchers, knowledgeable in bird song as well as sight identification. If the field trip is taken during bird migration, note which species breed in the area and which are migrating through. Mammals, reptiles, amphibians and fish (if in an aquatic environment) are less readily seen, and specialists in the latter animals might demonstrate methods of live-trapping or locating these animals by turning over rocks or netting. The identification of trees and plants, including ferns, mosses and lichens, will provide basic information about the habitat. If experts in some or all of these fields are available, or the team leaders are able to provide basic information, the group can be divided into subgroups, each of which will choose a type of life form, such as plants, invertebrates, birds or mammals. Once back in the classroom or environmental center, the various groups can meet and provide lists of the species they have seen in each area. Any rare, endemic or endangered species will be singled out and described in detail. This one-day project will not provide a complete picture of the biodiversity of an area but can give a general picture that is valuable. The effects that development has on nature and the need to protect wilderness and natural areas will become apparent through such a study. In general, biological diversity increases the farther one gets from large cities and suburban areas. Keep in mind, however, that some extremely rare species, especially plants and insects, have managed to survive in small pockets of wild habitat in unexpected places. Weedy growth next to railroads, for example, has been found to harbor many rare plants and insects. Such areas, never cleared for development, have remained natural. Open space, even with low biological diversity, is preferable to asphalt, and students may contribute ideas on making city parks and suburban backyards more diverse by planting trees and shrubs and allowing brushy areas to grow. More advanced students can participate in the CD-ROM biodiversity study listed below (see Wilson and Perlman 1999).

o **Bird feeding.** Another project involves appreciation of biodiversity with the potential for making a contribution to ornithology. Backyard bird feeders can provide an eye-opening education in biodiversity that is also extremely enjoyable. Bird feeders attract many common seed-eating birds. Adding suet and fruit can bring woodpeckers, orioles and other fruit-eating birds. The number of species that come to bird feeders is related to the habitat and surrounding area. Feeders in remote habitats or located on bird migratory flyways will attract more species than those placed in the city, which are likely to attract pigeons, sparrows and starlings, all European in origin. Sometimes, a rare species comes to the bird feeder to feed or is attracted as a predator on the birds. Bird feeders can provide important data on bird diversity and population trends. Cornell's Laboratory of Ornithology (159 Sapsucker Woods Road, Ithaca, NY 14850-1999 (Tel: 607-254-2473) conducts a program that enrolls volunteers to keep track of the birds that visit their feeders. By providing a wide variety of seed and other food, one can learn much about diets, how the birds feed, their behavior and plumage changes throughout the year. Books about bird feeding are sold in most book stores, and local chapters of the National Audubon Society provide information on feeders and feed. Television advice is given by Don and Lillian Stokes in their PBS series.

o **Bird-watching.** Bird-watching trips are important in learning about the majority of species that do not come to bird feeders or live in suburban backyards. Insect-eaters, such as warblers, flycatchers, vireos and other songbirds, can be seen only on migration or in their natural environments. During migration, especially in the spring, the beauty of these colorful birds, called "living jewels" by many naturalists, can be appreciated by using binoculars. Excursions to various habitats to see birds will also teach the diversity of environments, threats to them, and which types harbor the greatest diversity of birds. Local bird clubs, National Audubon Society chapters and naturalist clubs are sources of information on the best birding spots and times of year when one is likely to see the greatest number of birds. Many of these organizations conduct birding trips, both in the United States and in foreign countries. Declines in avian

diversity and in population numbers will become evident after participation in several of these trips. Sources of information on such trends include trip guides who have been conducting tours or breeding bird surveys of the US Fish and Wildlife Service or the National Audubon Society over a period of years in the same habitat. Ask them for information on species that have declined or disappeared altogether as a result of environmental changes, pollution or other causes. Note the species of birds seen on the trip and find out from the guide or other authority, such as the US Fish and Wildlife Service or National Audubon Society, whether these species have declined over recent years. For example, shorebirds seen on coastlines or in the Mississippi River region have suffered dramatic losses of up to 90 percent in some species over the past 30 years. The causes are diverse, from overfishing of food sources, disturbance of beach nesting areas, loss of habitat in wintering or nesting grounds to killing on their wintering grounds. On the list of species seen, note population trends and their causes in the area visited.

o **Worldwide perspective.** Learning about biodiversity from a worldwide perspective is key to understanding the subject. Dr. Edward O. Wilson of Harvard University coined the word "biodiversity" in the 1988 book of that title that he edited. His other book on the subject is also a primary resource. Both give overviews of the world's wealth of species and risks to them. Another important basic reference, *Conserving Biological Diversity*, by Jeff McNeely and other authors, is a 1990 overview of the problem, with key species and regions described. This leads to *Hotspots*, written a decade later in 2000 by Dr. R.A. Mittermeier and others. This book identifies hotspots as the world's most endangered high-biodiversity areas and discusses each in terms of geography; habitat; which species are native, especially those that are found only that in particular area (endemic species); statistical biodiversity for each area; threats to the area; and what is being done to conserve them. Clive Ponting's *A Green History of the World* helps explain why past civilizations have died out as a result of ignorance and overexploitation of their environment and the native wildlife upon which they depended. Michael J. Novacek of the American Museum of Natural History edited a 2001 book, *The Biodiversity Crisis. Losing What Counts*, a collection of essays by prominent scientists and conservationists who discuss the increasing rate of extinctions and give case history examples of areas at risk and what strategies are working to help protect them. The other references listed below provide additional information.

- Write an essay on the problem of the loss of biodiversity, emphasizing the reasons why it is important to the future of human society, as well as for the sake of conservation.
- List ways that consumers in the United States who buy tropical hardwoods and other goods, use large amounts of non-renewable energy and produce greenhouse gases, affect the loss of biodiversity.
- Choose a country or area that has high biodiversity, such as Colombia, Madagascar or Indonesia, and describe the geography, climate, type(s) of biological diversity, threats, unique species of plants and animals, conservation programs, and whether they are successful. Calculate the losses of species should the present rate of deforestation or other destruction continue, using references such as *Hotspots* and *Threatened Birds of the World.*

o **Species in danger.** Learning about threatened plants, birds, mammals and other species will provide in-depth knowledge of what is at stake. *Threatened Birds of the World* examines the 1,100 species whose future survival is in danger. This book illustrates each species with range maps, status and other background information. Many of these birds are illustrated in *The Life of Birds,* a book by David Attenborough, and in a 10-hour film series based on it seen on PBS. The Video section describes other films about threatened species. Other threatened animals and plants surveyed by the *2000 IUCN Red List of Threatened Species* are not described in depth by the International Union for the Conservation of Nature and Natural Resources (IUCN), which sponsors this list. The IUCN no longer publishes "Red Data Books," which gave background information on each species. The Internet site (www.redlist.org) provides some information, such as distribution and basic status category, but few listings give causes of the status and other related data. Such information gaps are filled in part by publications such as *Walker's Mammals of the World,* a two-volume, in-depth examination of mammals by Dr. Ronald Nowak, regularly updated and last issued in 1999. The IUCN Species Survival Commission sponsors many individual specialist groups that gather information on elephants, rhinos, whales, primates and many other categories. These groups issue newsletters and have websites. (Contact the SSC Red List Programme Officer, 219c Huntingdon Road, Cambridge CB3 0DL, UK; e-mail redlist@ssc-uk.org). Select a group of species, such as salamanders, frogs or orchids, and describe their general status. How many species are threatened? What are the general causes? What areas of the world do they inhabit? What will be the effect on

other animals or plants in their ecosystems should they disappear? What should be done to preserve them?

Books and Publications
Video

Biodiversity: Books and Publications

Attenborough, David. 1979. *Life on Earth. A Natural History*. Little, Brown & Co., Boston, MA, 319 pages.

Attenborough, David. 1984. *The Living Planet. A Portrait of the Earth*. Little, Brown & Co., Boston, MA, 320 pages.

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Ayensu, Edward S., Vernon H. Heywood, Grenville L. Lucas and Robert A. Defilipps. 1984. *Our Green and Living World. The Wisdom to Save It*. Smithsonian Institution Press, Washington, DC, 255 pages.

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Inc., Publishers, New York, 176 pages.
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Hardin, Garrett. 1993. *Living Within Limits. Ecology, Economics, and Population Taboos*. Oxford University Press, New York, 339 pages.
Hoose, P.M. 1981. *Building an Ark: Tools for the Preservation of Natural Diversity Through Land Protection*. Island Press, Covelo, CA, 212 pages.
Howes, Chris. 1997. *The Spice of Life. Biodiversity and the Extinction Crisis.* Blandford, A Cassell Imprint, London, UK, 192 pages.
Huston, M.A. 1994. *Biological Diversity: The Coexistence of Species on Changing Landscapes*. Cambridge University Press, Cambridge, UK.
Karliner, Joshua. 1997. *The Corporate Planet. Ecology and Politics in the Age of Globalization.* Sierra Club Books, San Francisco, CA, 298 pages.
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Laurance, W.F. and R.O. Bierregaard, Jr. (eds.). 1997. *Tropical Forest Remnants. Ecology, Management and Conservation of Fragmented Communities.* University of Chicago Press, Chicago, IL.
Lovejoy, T.E., J.M. Rankin, R.O. Bierregaard, Jr., K.S. Brown, Jr., L.H. Emmons and M.E. Van der Voort. 1984. Ecosystem Decay of Amazon Forest Remnants. In: *Extinctions.* Ed. by M.H. Nitecki. University Chicago Press, Chicago, IL.
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Areas. International Union for the Conservation of Nature, Gland, Switzerland.
Noss, Reed F. and Allen Y. Cooperrider. 1994. *Saving Nature's Legacy. Protecting and Restoring Biodiversity.* Island Press, Washington, DC, 443 pages.
Novacek, Michael J. (ed.). 2001. *The Biodiversity Crisis. Losing What Counts.* An American Museum of Natural History Book, The New Press, New York, 224 pages.
Nowak, Ronald M. 1999. *Walker's Mammals of the World.* Vols. I and II. Johns Hopkins University Press, Baltimore, MD.
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Peters, C.M., A.H. Gentry and R.O. Mendelsohn. 1989. Economic valuation of an Amazonian rainforest. *Nature*, 339:655-656.
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Rich, Bruce. 1994. *Mortgaging the Earth. The World Bank, Environmental Impoverishment, and the Crisis of Development*. Beacon Press, Boston, MA, 376 pages.
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Soulé, Michael E. (ed.). 1986. *Conservation Biology: The Science of Scarcity and Diversity*. Sinauer Associates, Sunderland, MA.
Terborgh, John. 1999. *Requiem for Nature.* Island Press, Shearwater Books, Washington, DC, 234 pages. (Examines Manu National Park, Peru, and others as examples of the failure of present land protection programs to preserve biodiversity, and proposes alternative solutions.)
Turner, B.L. II, William C. Clark, Robert W. Kates, John F. Richards, Jessica T. Mathews and William B. Meyer (eds.). 1990. *The Earth as Transformed by Human Action. Global and Regional Changes in the Biosphere over the Past 300 Years*. Cambridge University Press, Cambridge, UK, 713 pages.
Wilson, Edward O. (ed.). 1988. *Biodiversity*. National Academy Press, Washington, DC, 521 pages.
Wilson, Edward O. 1992. *The Diversity of Life*. W.W. Norton & Co., New York, 424 pages.
Wilson, Edward O. and Dan L. Perlman. 1999. *Conserving Earth's Biodiversity.* Island Press, Covelo, CA. (Interactive CD-ROM that teaches conservation biology and environmental science; teachers may view demo at www.Islandpress.org/wilsoncd/ and register for an examination copy.)
Wolf, Edward C. 1987. *On the Brink of Extinction: Conserving the Diversity of Life*. Worldwatch Institute, Washington, DC.

Biodiversity: Video
"Biodiversity: The Variety of Life" explains what biodiversity is and why we should protect it. This film uses maps, diagrams and examples to introduce new terms and concepts, including fragmentation, linkage, and viable population, to explain how ecosystems are dynamic and varied. It focuses on the North Cascades ecosystem, but presents general concepts.

"State of the Planet" is a 3-hour BBC Bristol film on the biodiversity crisis made for Discovery Communications in 2000. It examines the rise in extinctions and endangered species and causes such as "islandization" or isolation of habitat surrounded by development; it profiles Hawaii as leading the world in extinct and endangered species, its beautiful natural heritage being destroyed by exotic species and disappearance of native forests. The final hour of this film series, "The Future of Life," makes clear that if we do not act soon, great natural treasures will be lost.

"Natural Connections," produced by Howard Rosen for PBS in 2000, is a one-hour examination of the failure of the United States and other developed countries to protect nature. It links extravagant and unthinking lifestyles with the loss of biodiversity and proposes changes that will have direct effects in terms of preserving species.

Bats: Ecologically Important Mammals
Project Summary
Learning about bats and threats to them is the major purpose of this project, as well as understanding the importance of bats to the environment as pollinators, seed dispersers and insect-eaters. An endangered bat species will be selected as the subject of a report. Conservation of bats through the protection of their habitats and building of bat houses will be an important facet of this project.

Background
Bats comprise almost one-fourth of all mammals--nearly 1,000 species--yet they have not received the attention and credit they deserve as major insect-controllers and pollinators in ecosystems worldwide. Many species are becoming endangered, and others are declining from destruction of their nesting caves, direct persecution from ignorance, closure of mines which many bats had colonized, and indiscriminate use of pesticides.

Until recently, bats were routinely poisoned by commercial pest control companies in the mistaken idea that all bats pose the threat of rabies transmission. Only one-half of 1 percent of bats contract rabies. Over the past 45 years, only 20 people in the United States and Canada have contracted the disease from bats, according to Bat Conservation International, an organization dedicated to the conservation of bats and education about their ecological roles. Most problems involve people carelessly picking up obviously sick bats found out in the open or on the ground in the daytime. These should always be avoided, according to Dr. Merlin D. Tuttle, Founder and Executive Director of Bat Conservation International. Pest control companies in the United States are now adopting new and more informed policies regarding the removal of unwanted bats from buildings. The journal *Pest Management,* in its May 1992 edition, published several articles on how to "bat-proof" buildings without use of lethal means, and the usefulness of bats in controlling insects.

A single Brown Bat, one of North America's most common species, is capable of capturing 600 mosquitoes in an hour (see Tuttle and Smith referenced below). One colony of 20 million Mexican Free-tailed Bats in central Texas eats a quarter of a million pounds or more of insects each night, according to Bat Conservation International. Repercussions

have occurred when bats have been destroyed. In Israel, a campaign to eradicate fruit bats instead killed almost 90 percent of the country's insectivorous bats; moths that were formerly controlled by the bats proliferated and became major agricultural pests (Tuttle and Smith). To control these pests, huge amounts of pesticides were used, further eliminating natural predators of insects and beneficial insects.

Nectar-feeding and fruit bats pollinate more than 130 genera of plants. The co-evolution of many bats and plants, the latter evolving prominent, odoriferous large flowers blooming at night with copious nectar and pollen, and the former specialized tongues and muzzles for flower-feeding and acute senses of sight and smell, is a fascinating study in itself. The statuesque Century Plant of southwestern deserts has co-evolved with a pollinating bat, and this plant blooms at rare intervals, using nectar to attract its pollinator (see Howell referenced below). Among plants that bats pollinate are valuable fruits, nuts and spices: plantain, bananas, breadfruit, mangos, guavas, avocados, almonds, cashews, cloves, vanillin, carob and figs. In Southeast Asia, a bat that pollinates the Durian tree, which produces fruit marketed for $120 million per year, is being killed for food and its caves quarried for limestone. Few people in the region are aware of its economic importance and the need to conserve it. Fruit bats throughout the world are killed for food, and a growing number are becoming endangered.

Many US bats are listed on the US Endangered Species Act as Endangered or Threatened or on the *2000 IUCN Red List of Threatened Species*. The Indiana Bat's entire population winters in only a few caves in the United States. Approximately 95 percent of the entire known Gray Bat population hibernates in only nine caves with more than half in a single cave in northern Alabama. The threatened Rafinesques Big-eared Bat is found only in Indiana, but it receives no federal protection from the US Endangered Species Act. The Nature Conservancy and many state Natural Heritage Programs have been instrumental in purchasing numerous caves to protect these species.

The following bats are either listed on the US Endangered Species Act or on the *2000 IUCN Red List of Threatened Species*. Some experts estimate that approximately 40 percent of US bats are declining or already endangered. Many species recognized by mammalogists as threatened or endangered and listed by the IUCN as Vulnerable, a high category of risk, have not been listed on the US Endangered Species Act.

Threatened United States Bats
(Includes territories)

Key:
E = Endangered
NT = Near Threatened
T = Threatened
V = Vulnerable
X = Extinct

For definitions of these categories, see the list of Endangered and Threatened Mammals, Birds, Reptiles and Amphibians in the Appendix of this book.

Species	Distribution	US ESA	IUCN Red List
Big Long-nosed Bat *Leptonycteris nivalis*	US, Mexico, Guatemala	E	E
Brazilian Free-tailed Bat *Tadarida brasiliensis*	sw US to S. America		NT
California Leaf-nosed Bat *Macrotus californicus*	US, Mexico		V
	c. & se US	E	E

Gray Bat *Myotis grisecens*			
Hairy-legged Vampire Bat *Diphylla ecaudata*	US, Mexico to Peru		NT
Hawaiian Hoary Bat *Lasiurus cinereus semotus*	US (Hawaii)	E	
Hog-nosed Bat *Choeronycteris mexicana*	US, Mexico, C. America		NT
Indiana Bat *Myotis sodalis*	e. & Midwest US	E	E
Lesser Long-nosed Bat *Leptonycteris curasoae*	US to S. America		V
Sanborn's *L.c. yerbabuenae*		E	
Little Mariana Flying Fox *Pteropus tokudae*	Guam	E	X
Marianas Flying-fox *Pteropus mariannus*	SW Pacific		E
Guam *P.m.mariannus*		E	
Mexican Long-nosed Bat, see Big Long-nosed Bat			
Rafinesque's Big-eared Bat *Plecotus rafinesquii*	US (Indiana)		V
Townsend's Big-eared Bat *Plecotus townsendii*	US		V
Ozark *Plecotus townsnedii ingens*		E	
Virginia *Plecotus townsendii virginia*		E	
Underwood's Mastiff Bat *Eumops underwoodi*	US to Central America		NT

In addition, each state Natural Heritage Program has a list of threatened or rare mammals, many of which include bats. The major threats to bats in North America are similar to those in foreign countries. They include the cutting of old-growth forests that provide habitat, pesticide use, deliberate poisoning and destruction of caves where many bats winter.

Activities

o Find out which bats live in your area. For distribution information, consult guide books such as *North American Mammals*, published by the National Audubon Society. Use reference books such as *Bats*, by M. Brock Fenton (1992), *America's Neighborhood Bats*, by Merlin D. Tuttle (1988), and *Walker's Mammals of the World***,** by Ronald Nowak. Bat Conservation International has published a beautiful brochure, "Bats: Gentle Friends, Essential Allies," and a fact sheet, "Important Bat Facts." Different species of bats can occupy the same general area, yet have different

diets and habitats. How do the bats in your area differ in these ways? What do they eat? Contact the Natural Heritage Program of your state and ask them if there are important bat habitats, such as caves, that are endangered and how your class or local organization can help save these habitats.

o Select a threatened species of bat and write a report on its status, life history, threats and what is being done for its conservation. Consult the references below and your state's Natural Heritage Program.

o Discuss the ecological importance of bats. What fruits and other plants important to humans are pollinated by bats? What would be the effect on insect populations if bats disappeared? *Bats in Question*, by Don E. Wilson, listed below, is a very useful book for information on this subject.

o Help dispel the image of bats as dangerous, rabid creatures who should be eliminated. Humane means of keeping bats from entering buildings exist, and local animal control officials and public health officials should be provided with such information, available from Bat Conservation International. Also, letters to the editor of your local newspaper can be helpful, especially if an article about rabies or vampire bats has been printed. Point out that bats are extremely beneficial and vital to the survival of many plants.

o Build a bat house as a class project. The instructions for construction and placement are given in "The Bat House Builder's Handbook" from Bat Conservation International and a video that gives instructions and general information. This pattern prevents mortality to bats from improper design, materials and placement. Once constructed, calculate the number and species of bats that will occupy the house(s) and the number of insects they will consume.

o Bats have many highly unusual characteristics. Many have echo-location sonar far more sensitive than that designed by humans. Others are able to hunt unusual prey, such as fish or frogs. Their abilities are so finely developed that they are only beginning to be understood. They also are intelligent and devoted to one another. They are among the few species who aid one another during the birthing process, as "animal midwives." Consult the books and films listed below and write a paper on a particular trait that you find fascinating.

Books and Publications

Allen, Glover M. 1962. *Bats.* Dover Publications, New York.
Fenton, M. Brock. 1992. *Bats*. Facts on File, New York.
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Howell, Donna J. 1976. Plant-loving Bats, Bat-loving Plants. *Natural History* (magazine of the American Museum of Natural History, New York), Feb.
Nowak, Ronald M. 1999. *Walker's Mammals of the World* (Volume I), Johns Hopkins University Press, Baltimore, MD. *(Walker's Bats of the World*, another reference by the same author, is derived from the latter volume.)
Tuttle, Merlin D. 1988. *America's Neighborhood Bats*. University of Texas Press, Austin, TX.
Tuttle, Merlin D. and Eileen C. Smith. 1992. Bats: Nature's Own PCO. *Pest Management,* May, Vol. 11, No. 5, pages 10-13.
Wilson, Don E. 1997. *Bats in Question. The Smithsonian Answer Book*. Smithsonian Institution Press, Washington, DC. (Source book with questions and answers about bats and superb photography by Merlin D. Tuttle; addresses of organizations concerned with bat conservation are listed at the end of the book along with a list of all bats with their conservation status.)

Films

"Korup. An African Rain Forest." A Cameroon forest where bats are seen pollinating flowers at night.

"The Secret World of Bats." Overall view with the role of bats as pollinators and insect-eaters is stressed, and unusual species, such as fish-eating and threatened fruit bats, are seen.
"Wet Side Story." Central American rainforest with bats as a focal point. The sensitivity of their sonar is beautifully filmed.
"Private Life of Plants." Includes pollination by bats of several species of plants and describes how plants and bats co-evolved.
"Castaways of Sulawesi." An Indonesian island is the scene of cruel capture of flying foxes for sale as food by young boys using hooks on kites that entangle them in flight.

The films above are described in detail in the Video section of this book.
In addition, other films that focus on bats include "Phantom of the Night" (bats of Central America); "Beneficial Bats" (Wild America series); "Land of the Giant Bats" (Comoros flying foxes); "Life Upside Down" (Quebec Government film emphasizing Canadian bats and their ecological role); "Night Stalkers" (bats of Belize--National Geographic Explorer TV program).

Slide Show
"Bats of America," by Bat Conservation International.

Further Information
Bat Conservation International, P.O. Box 162603, Austin, TX 78716; website: www.batcom.org
US Fish and Wildlife Service, Office of Endangered Species, Washington, DC 20240
State Natural Heritage Programs

Internet: e-mail discussion "Batline"--batline@unmvma.unm.edu

Conserving the Wood Thrush
Project Summary
Learn about the life history, distribution, ecology and conservation of the Wood Thrush, a songbird in steep decline. Using written materials and sources listed below, write a report on the threats it faces and what is needed to help it survive. For those who live in areas where the Wood Thrush is not native, select another declining songbird and follow the same suggestions.

Background
The Wood Thrush (*Catharus mustelinus*) is one of the most melodious songbirds in the world. Its beautiful, fluted song echoes through eastern North America's woodlands. In the words of Arthur Cleveland Bent, author of a series of authoritative life history studies of American birds: "The nature lover who has missed hearing the musical bell-like notes of the wood thrush, in the quiet woods of early morning or in the twilight, has missed a rare treat. The woods seem to have been transformed into a cathedral where peace and serenity abide. One's spirit seems truly to have been lifted by this experience."

The Wood Thrush is also useful to forest ecosystems, consuming vast amounts of insects. Unfortunately, its populations have declined in recent years from 40 to 80 percent, depending on the area. Major causes include the destruction of both its nesting and wintering forests, combined with parasitism on its nests by the Brown-headed

Cowbird, a bird that lays its eggs in the nests of other birds. These eggs tend to be larger than the eggs laid by the Wood Thrush, and the aggressive chicks crowd out the thrush chicks. Wood Thrushes are closely related to the familiar American Robin, a common denizen of suburban yards and forests. Unlike the Robin, however, the Wood Thrush is not common in suburbs and backyards. Although the species was occasionally seen near homes and villages in the first half of the 20th century, today it breeds only in undisturbed forest tracts. Its forest habitats have become fragmented into smaller and smaller blocks, causing the species to disappear from many areas.
Wood Thrushes migrate to Mexico and Central America each winter. They seek out old-growth rainforests from southern Mexico through Panama. Within the past 40 years, their forests have been logged and often converted into grazing land or agricultural fields. Researchers tracking these birds to their wintering grounds have discovered that they stay in the same area, even though it has been destroyed, and usually die within a short period from starvation or predation. The decline in this species' population was discovered through Breeding Bird Surveys conducted annually by the US Department of Interior. The Wood Thrush is close to endangered status, and conservation is critical to prevent its decline to extinction.

Other North American songbirds that migrate to tropical areas have declined as well. These birds, known as neotropical migrants, include tanagers, orioles, warblers, thrushes and vireos. These colorful birds brighten our forests and orchards, consume harmful insects and play important ecological roles. Almost all are in decline, some far more precipitously than others.

Activities

o Find out about the Wood Thrush, using the text in this book (see index), sources listed below and those available in your library and through computer on-line searches.

o Write a report answering as many of these questions as possible:
- What does the Wood Thrush look like?
- How large is it?
- Are males and females different in size or appearance?
- What is its diet?
- What type of woods does it prefer (for example, dry, old-growth forest or cool, damp forest near streams)?
- Does it build its nest on the ground, in bushes, or on tree branches?
- How large a territory does it establish?
- When does it sing? Describe its song (see reference on obtaining recording).
- How long does it live?
- What are its breeding and wintering ranges?
- How did early naturalists, such as John James Audubon, describe Wood Thrushes in the 19th century? (See Audubon and Coues book below.)
- How serious is the threat from Brown-headed Cowbirds who lay their eggs in Wood Thrush nests? (This was noted even in the 1930s by Bent (1964), and later by other authors such as Rappole *et al.* (1989), and Terborgh (1989.)
- How can people contribute to protecting both the breeding and wintering habitat of the Wood Thrush?

o Field study**:** If you live east of the Mississippi River in the range of this species, visit an area where Wood Thrushes live**.** First, listen to the recording of their songs (see below). Often they are more easily heard than seen. Do not approach a nest or disturb birds by playing recordings of their songs. Photograph the woodland setting where you hear the Wood Thrushes and try to observe them quietly from a distance. Describe what wildflowers, trees and other birds you see. If you live outside their range, see films listed below and listen to recordings or select another species of thrush or songbird found in your area that is in decline as a result of habitat loss, especially forests. Consult your

local Audubon Society, the US Fish and Wildlife Service, your state's Natural Heritage Program or the bird count programs listed below.

o Conservation project**:** Find out if there is a woodland near your home where Wood Thrushes breed. The local National Audubon Society or birding organization can provide this information. If so, is it protected from logging? Can your class or school help in protecting a woodland where they breed?

o Participate in a survey of native birds through programs sponsored by local Audubon or birding organizations. The American Birding Association publishes an annual guide, "Volunteer Opportunities for Birders," which lists day-long programs and more extensive studies. Available for $2 from Volunteer Directory, ABA Sales, P.O. Box 6599, Colorado Springs, CO 80934; 800-634-7736. For further ideas, see Nickens reference below.

o Why are some species rare and others common? Compare the Wood Thrush with the American Robin by answering the following questions: Does the Robin migrate? If so, where does it migrate? Are there dangers in its wintering ground, such as deforestation? Where does the Robin nest? Is there more habitat for American Robins or for Wood Thrushes? Explain why. Are there threats to the American Robin?

Books and Publications

Adams, George. 1994. *Birdscaping Your Garden. A Practical Guide to Backyard Birds and the Plants that Attract Them.* Rodale Press, Emmaus, PA. (On page 87, the Wood Thrush is profiled, providing information about migration, breeding range, nesting, feeding, garden bushes and fruiting plants that it will eat, as well as the woodland habitat it prefers.)

Audubon, Maria R. and Elliott Coues. 1986. *Audubon and His Journals*. Vols. I and II. Dover Publications, New York. (First published in 1897, Audubon's journals were collected by Maria Audubon with notes by the distinguished naturalist Elliott Coues. Wood Thrushes are mentioned many times.)

Bent, Arthur C. *Life Histories of North American Thrushes, Kinglets, and Their Allies.* First published in 1949 and reprinted by Dover Publications, New York, 1964, pages 101-122.

Bull, John and John Farrand, Jr. 1977. *The Audubon Society Field Guide to North American Birds. Eastern Region.* Alfred A. Knopf, New York. (A photo guide.)

Cherry, Lynne. 1997. *Flute's Journey. The Life of a Wood Thrush*. A Gulliver Green Book. Harcourt Brace and Company, San Diego, CA; New York.

DeGraaf, Richard M. and John H. Rappole. 1995. *Neotropical Migratory Birds. Natural History, Distribution, and Population Changes*. Comstock Press, Cornell University, Ithaca, NY. (This book has range maps of all North American breeding birds that migrate to Latin America and several pages of discussion of each species.)

Farrand, John Jr. (ed.). 1983. *The Audubon Society Master Guide to Birding.* (Has color photo of adult at nest with chicks and a color painting of the juvenile.)

Forbush, Edward Howe and John Bichard May. 1959. *A Natural History of a Bird of Eastern and Central North America*. Bramhall House, New York, pages 377-378.

Geffen, Alice M. 1978. *A Birdwatcher's Guide to the Eastern United States*. Barron's, Woodbury, NY. (This and the Pettingill book below list major parks, refuges and public lands by state; under each is a list of birds to be seen.)

Hagan, John M. III and David W. Johnston (eds.). 1992. *Ecology and Conservation of Neotropical Migrant Landbirds*. Smithsonian Institution

Press, Washington, DC. (This book is not indexed. It is a collection of papers from a 1989 symposium, containing much information on the problems of songbirds, including the Wood Thrush, especially an article on destruction of its habitat in Veracruz, Mexico, on pages 337-344.)
Harrison, Colin. 1978. *A Field Guide to the Nests, Eggs and Nestlings of North American Birds.* The Stephen Greene Press, Brattleboro, VT; Lexington, MA. (This book describes the nest and nestlings and gives the nesting dates; a color photo shows the egg.)
Keast, Allen and Eugene S. Morton (eds.). 1980. *Migrant Birds in the Neotropics: Ecology, Behavior, Distribution and Conservation*. Smithsonian Institution Press, Washington, DC. (Papers submitted at a symposium. Many discuss the threats that migrant songbirds, including Wood Thrushes, face on their wintering range. The introduction gives an overview of the songbird decline.)
Kricher, John C. 1988. *A Field Guide to the Ecology of Eastern Forests. North America*. The Peterson Field Guide Series. Houghton Mifflin Co., Boston, MA. (This book contains information on hundreds of species of plants and animals, many of which are illustrated with color photos.)
National Audubon Society Nature Guides. *North American's Eastern Forests and Wetlands*. Alfred A. Knopf, New York.
Nickens, Eddie. 1997. Beyond the Life List. *Wildlife Conservation* magazine, July/August. (Wildlife Conservation Society, Bronx Zoo, Bronx, NY 10460.)
(This article describes the work of volunteers who participate in surveys, banding, birdfeeder studies and other projects relating to North American songbirds; it provides addresses and phone numbers of various organizations.)
Peterson, Roger Tory. *A Field Guide to the Birds. A Complete Guide to All the Birds of Eastern and Central North America*. Houghton Mifflin Co., Boston, MA. (This classic guide has excellent illustrations, breeding range map and descriptions.)
Pettingill, Olin Sewall, Jr. 1977. *A Guide to Bird Finding East of the Mississippi*. Oxford University Press, New York. (Although many of the areas described in this indexed book have changed since it was first written, many are protected sanctuaries, parks and reserves.)
Rappole, John H., Eugene S. Morton, Thomas E. Lovejoy III and James L. Ruos. 1983. *Nearctic Avian Migrants in the Neotropics*. US Fish and Wildlife Service and World Wildlife Fund, Washington, DC. (This publication is not indexed, but is a well-organized report on North American songbirds, their ecology and threats. Range maps show breeding range as well as wintering range of all migratory species.)
Sibley, David A. 2000. *The Sibley Guide to Birds*. Alfred A. Knopf, New York. (Considered one of most inclusive guides because it includes information on subspecies, varieties and other aspects not covered in most guides.)
Stokes, Donald and Lillian. 1996. *Stokes Field Guide to Birds. Eastern Region.* Little, Brown & Co., Boston, MA. (Color photos.)
Terborgh, John. 1989. *Where Have All The Birds Gone?* Princeton University Press, Princeton, NJ. (Many mentions in the text, see index; this is a landmark book on the decline in North American songbirds, exploring their problems on both the breeding and wintering grounds)
Yoon, C.K. 1994. More Than Decoration, Songbirds Are Essential to Forests' Health. *The New York Times*, Nov. 8.

Organizations and Governments

National Audubon Society, 700 Broadway, New York, NY 10003. (212-979-3000); or local chapters.

Conservation International, 1015 18th St., NW, Suite 1000, Washington, DC 20036.

Cornell Laboratory of Ornithology (Breeding Bird Censuses), 159 Sapsucker Woods Rd., Ithaca, NY 14850-1999 (607-254-2473).

Institute for Bird Populations, P.O. Box 1346, Point Reyes Station, CA 94956; (415-663-1436).

The Nature Conservancy, 1815 North Lynn St., Arlington, VA 22209 (and field offices throughout the country).

Natural Heritage Programs in every state in Department of Wildlife or Fish and Game.

US Fish and Wildlife Service, 4401 N. Fairfax Dr., Arlington, VA 22203.

Breeding Bird Survey, Biological Resources Division, US Geological Survey, Patuxent Wildlife Research Center, 12100 Beech Forest Rd., Laurel, MD 20708.

Fish and Wildlife Reference Service, 5430 Grosvenor Lane, Suite 110, Bethesda, MD 20814 (800-582-3421).

Recordings

The Peterson Field Guide Series. A Field Guide to Bird Songs of Eastern and Central North America, recorded by the Cornell Laboratory of Ornithology. 2nd edition. Houghton Mifflin Co., Boston, MA. 1983. Two tape cassettes. (Wood Thrush on Side 3, Band 4). Other recordings, such as the Stokes audio guides, are also available.

Films

"On a Wing and a Song." This Canadian Broadcasting Company film gives an overview of the songbird decline in Eastern North America, illustrating the vast areas of boreal forest where many of these birds nest in Canada, which has been logged. It addresses the loss of habitat in their tropical wintering grounds; the millions killed by colliding with skyscrapers and antennas during migration; and the parasitism by cowbirds.

"On a Wing and a Prayer." A similar title to the above film, this film focuses on an Illinois woodland and the decline in songbirds, primarily Wood Thrushes. The parasitism by cowbirds is dramatically shown: Wood Thrush chicks starve to death next to huge, fat cowbird chicks. This film also has a teacher's guide.

(See Video section for more detail and distributor list.)

North America in the Year 1400

Project Summary and Background

North America has changed radically since 1400, prior to the arrival of Europeans. It was then a continent without roads, skyscrapers, massive farms and other signs of modern life. This project involves research to discover what the country looked like at this early date, how areas such as the eastern forests, prairies and western forests have changed, and what species of animals and plants disappeared or became threatened as a result of changes to their environment or losses in their populations from other causes.

Activities

o Read the section in this book entitled "Epitaphs for North America's Lost Species and Environments" in Chapter 1.

o Using this and other sources mentioned in the reference list and in local libraries, select an area somewhere in North America. Some possible choices are the following: Cape Cod, Massachusetts; the Chesapeake Bay; eastern old-growth forests; long-grass prairies of the Midwest; short-grass prairies of the West; Sequoia or Redwood forests of California; or the Mojave Desert in California. If there are parks in the area you choose, contact the park directors, conservation organizations and museums for natural history information.

- Describe the landscape as it was prior to the arrival of Europeans, without roads, modern buildings or other signs of the 20th century. What was the habitat like? Was it forest, mountain, grassland, desert, wetland, river or a combination of these? Were there beautiful vistas or dense woodlands with tangled vegetation? Describe a typical scene in the area you have chosen. For example, in a short-grass prairie, a herd of American Bison graze while, in the background, Pronghorn antelope run in close formation. On a distant hilltop, a pack of Gray Wolves watches the scene while a Grizzly Bear ambles through the low shrubs, looking for ripe berries. Overhead, flocks of Whooping Cranes soar, trumpeting to one another; and near a prairie dog town, grouse display in an open area, issuing booming calls.

- What species of mammals live here? If there are herds of deer, what species are they? Are there American Bison, Elk, Moose, Bighorn Sheep or Pronghorn? What kind of predators prey on these animals?

- Describe what bird species inhabit the area and whether they are abundant or rare. Are there Passenger Pigeons or Carolina Parakeets?

- What other kinds of animals are native? What reptiles, amphibians and fish, for example, inhabit the area? Apply the same questions about life history, habitats, reproduction and feeding.

- How do these animals interact ecologically? For example, if a western short-grass prairie were chosen, the prairie dog colony has abundant wildlife living underground in the burrows, including Black-footed Ferrets, Burrowing Owls, snakes and tortoises. Bison and other grazing animals feed on the grasses above, made greener by the cropping of the prairie dogs. Which species are the predators, and which the prey?

- Is there a tribe of Native Americans who live in this area? What is the name of the tribe? Are they nomadic, or have they established a permanent settlement? Are they hunters, fishers or farmers? What animals do they hunt or fish, or which crops are grown? What are their beliefs about the natural world and wildlife?

o Based on these descriptions of a past landscape, become acquainted with the present landscape and discuss the following:

- How has the natural environment changed? How does it appear today?

- What species no longer live here? Which ones are extinct altogether? (Check the list of extinct species in the Appendix and publications in the Books and Publications section on extinctions and extinct species accounts.)

- What do you think has been lost that should have been protected?

- Are there parts of this area that have not changed and remain as they were 600 years ago?

- Are there people or organizations working to preserve or restore parts of the original landscape and wildlife? How

can you participate in this?

Note: This project can be applied to foreign countries or used by teachers outside of North America. As a general rule, it is easier if the area selected is local because information is easier to obtain. As a class project, students might divide into groups, each selecting a species or group of species, such as mammals. This project may be shortened and parts deleted if time is limited, concentrating, for example, on a single species of the region or the general changes in the landscape. It may also be broadened to explore, in detail, the plants and animals of the region by contacting the Natural Heritage Program of your state in the Wildlife Department.

Sources

"Epitaphs for North America's Lost Species and Environments" in Chapter 1 of this book has extensive references listed. Also the fiGrasslands, Shrublands and Deserts,fl fiAquatic Ecosystemsfl and fiForestsfl chapters provide details on these ecosystems and changes in them since settlement. See the fiPersecution and Huntingfl chapter for the treatment of native predators and the effect of their disappearance on ecological systems.

Books and Publications

The following list contains many out-of-print books that may be difficult to obtain, as well as many in-print editions, covering a wide variety of habitats and species of plants and animals. Conduct searches for these and other books in your library and through the Internet.

Ambrose, Stephen E. 1996. *Undaunted Courage. Meriwether Lewis, Thomas Jefferson, and the Opening of the American West*. A Touchstone Book, Simon & Schuster, New York.

Audubon, Maria R. 1897. *Audubon and His Journals*. Vols. I and II. Dover Publications, Inc., New York edition, 1994.

Beard, Daniel. 1942. *Fading Trails. The Story of Endangered American Wildlife*. Macmillan Co., New York.

Blaugrund, Annette and Theodore E. Stebbins, Jr. (eds.). 1993. *John James Audubon. The Watercolors for the Birds of America*. Villard Books, Random House/New York Historical Society, New York.

Brower, Kenneth. 1990. *Yosemite. An American Treasure*. National Geographic Society, Washington, DC.

Chadwick, Douglas. 1990. *The Kingdom. Wildlife in North America*. Sierra Club Books, San Francisco, CA.

Cokinos, C. 2000. *Hope is the Thing with Feathers. A Personal Chronicle of Vanished Birds.* Warner Books, New York.

Davidson, Art. 1989. *Alakshak. The Great Country*. Sierra Club Books, San Francisco, CA.

Devall, Bill (ed.). 1993. *Clearcut. The Tragedy of Industrial Forestry*. Sierra Club Books/Earth Island Press, San Francisco, CA.

DiSilvestro, Roger L. 1989. *The Endangered Kingdom. The Struggle to Save America's Wildlife*. Wiley Science Editions, John Wiley & Son, New York.

Douglas, William O. 1968. *My Wilderness, The Pacific West*. Pyramid Books, Salem, MA.

Dunlap, Thomas R. 1988. *Saving America's Wildlife*. Princeton University Press, Princeton, NJ.

Feduccia, Alan (ed.). 1985. *Catesby's Birds of Colonial America*. University of North Carolina Press, Chapel Hill, NC; London, UK.

Fisher, Ron. 1984. *Our Threatened Inheritance. Natural Treasures of the United States*. National Geographic Society, Washington, DC.

Forbush, Edward Howe and John Bichard May. 1959. *A Natural History of American*

Birds of Eastern and Central North America. Bramhall House, New York.
Frome, Michael. 1974. *Battle for the Wilderness*. Praeger Publishers, New York.
Fuller, Errol. 2001. *Extinct Birds*. Cornell University Press, Ithaca, NY.
Geist, Valerius. 1996. *Buffalo Nation. History and Legend of the North American Bison*. Voyageur Press, Stillwater, MN.
Gleason, Herbert W. 1971. *Thoreau's Cape Cod*. Barre Publishers, Barre, MA.
Goudie, Andrew. 1982. *The Human Impact. Man's Role in Environmental Change*. MIT Press, Cambridge, MA.
Grey Owl (Wa-Sha-Quon-Asin). 1937. *Tales of an Empty Cabin*. Dodd, Mead & Co., New York.
Grove, Noel 1992. *Preserving Eden. The Nature Conservancy*. Harry N. Abrams Inc., New York.
Gunter, A.Y. 1972. *The Big Thicket. A Challenge for Conservation*. Chatham Press Inc., Riverside, CT.
Hanley, Wayne. 1977. *Natural History in America. From Mark Catesby to Rachel Carson*. Quadrangle/New York Times Books, New York.
Hawke, David (ed.). 1970. *Captain John Smith's History of Virginia. A Selection*. Bobbs-Merrill Educational Publishing, Indianapolis, IN.
Haynes, Bessie Doak and Edgar Haynes (eds.). 1979. *The Grizzly Bear. Portraits from Life*. University of Oklahoma Press, Norman, OK.
Highwater, J. 1995. *Native Land*. Barnes & Noble, New York.
Hornaday, William T. 1913. *Our Vanishing Wild Life*. New York Zoological Society, New York.
Josselyn, John. 1972. *New-England Rarities Discovered* (reprint of 1672 book), Massachusetts Historical Society.
Kopper, Philip. 1991. *The Wild Edge. Life and Lore of the Great Atlantic Beaches*. 2nd edition. The Globe Pequot Press, Chester, CT.
Kricher, John C. 1988. *Ecology of Eastern Forests*. Peterson Field Guides. Houghton Mifflin Co., Boston, MA.
Laycock, George. 1990. *The Hunters and the Hunted. The Pursuit of Game in America from Indian Times to the Present*. An Outdoor Life Book, Meredith Press, New York.
Madson, John. 1993. *Tallgrass Prairie*. A Nature Conservancy Book, Falcon Press, Helena, MT.
McMillan, Ian. 1968. *Man and the California Condor*. E.P. Dutton & Co., Inc., New York.
Middleton, David. 1992. *Ancient Forests. A Celebration of North America's Old-growth Wilderness*. Chronicle Books, San Francisco, CA.
Mowat, Farley. 1986. *Sea of Slaughter*. Atlantic Monthly Press and Bantam Books, New York.
Peck, Robert McCracken. 1990. *Land of the Eagle. A Natural History of North America*. Summit Books, New York. (See Selected Bibliography in this book, page 282.)
Ponting, Clive. 1991. *A Green History of the World. The Environment and the Collapse of Great Civilizations*. Penguin Books, New York.
Schorger, A.W. 1955. The Passenger Pigeon. Its Natural History and Extinction. University of Oklahoma Press, Norman, OK.
Seton, Ernest Thompson. 1899. *Wild Animals I Have Known*. 1966 edition, Grosset & Dunlap, New York.
Seton, Ernest Thompson. 1911. *The Arctic Prairies*. 1981 edition, Harper & Row, New York.

Teal, John and Mildred Teal. 1969. *Life and Death of the Salt Marsh*. Audubon/ Ballantine Book, New York.
Thomas, Bill. 1976. *The Swamp*. W.W. Norton & Co., New York.
Thoreau, Henry David. *Walden or Life in the Woods* (many editions).
Van Doren, Mark (ed.). 1955. *Travels of William Bartram*. Dover Publications, New York.

Forests

Project Summary

This project involves learning about the types of forests that grow on Earth and selecting one type of forest to describe in detail in terms of the climate, what types of trees grow there and what species of native plants and animals are threatened. It also involves learning about the ways in which this type of forest is being conserved or destroyed.

Background

As described in the Forests and Madagascar and Other Islands chapters, forests harbor the largest number of endangered species of all habitats. Uncontrolled logging, especially of old-growth forests, has threatened the survival of thousands of native plants and animals. Forests are a crucial factor in maintaining the planet's oxygen supply and supplying moisture to the atmosphere. By absorbing vast amounts of carbon dioxide, forests reduce pollution and global warming. Their roots also anchor soils, preventing erosion, and store moisture that gradually seeps into rivers and streams so that they flow year-round, even in droughts.

The world land area covered by forests has been retreating for centuries. Although there are still extensive boreal forests in northern Canada and Siberia, and tropical forest still covers most of the Amazon, forests are being logged at a fast pace. The increase in human populations has resulted in growing numbers of people cutting forests for firewood or to clear land for agriculture. In many parts of the world, forests with extraordinary diversity of life have been nearly eliminated or are in the process of being destroyed. Central Africa's ancient rainforests are being logged for the largest trees, hundreds of years old, and their wildlife, including endangered chimpanzees and Gorillas, is being slaughtered to sell in bushmeat markets. Tropical rainforests, especially those growing in lowland areas, are the most threatened type of forest. These forests harbor the largest diversity of wildlife and plants and are, therefore, most in need of protection. In the United States, entire forest ecosystems have become endangered, and many species of native trees have become threatened, some from diseases of foreign origin, others from logging and development. Examples of threatened forest ecosystems in North America are the native pine forests of the Southeastern United States, the old-growth temperate rainforests of the Northwest and the old-growth forests of the East.

Many species of trees, including the stately American Elm and the American Chestnut, have been decimated by exotic species of fungi. These trees once numbered in the billions. The American Elm has declined and disappeared from many parts of the East, and the American Chestnut is almost extinct throughout its range in eastern North America. It once made up a large portion of the eastern hardwood forests. The wildlife of these forests has lost much of its diversity, as the Gray Wolf, Red Wolf, Mountain Lion, and their prey, the Elk, Eastern Bison and, in northern woods, the Caribou were all hunted to the last animal. Rainforests of the Pacific Northwest, with their towering American Redwoods and Sequoias, Western Hemlock, Red Cedar and other conifers, have been reduced to about 5 to 10 percent of their original range as a result of logging and development. Their wildlife, likewise, is under siege, and many species, including the Grizzly Bear, Fisher, Lynx, Gray Wolf, Northern Spotted Owl and Marbled Murrelet, are absent or extremely rare.

Endangered trees and wildlife of temperate forests in South America include the massive Chilean Larch or Alerce, which can grow for 4,000 years and reach sizes almost as great as the Sequoias of California, the world's most

massive trees. Alerces have been decimated, cut for their valuable wood, along with other trees in these forests--species which grew on Earth prior to the appearance of dinosaurs. Vast forests of beeches, for example, and primitive conifers covered millions of square miles in Chile and Argentina, but only a fraction remain, the rest logged to make way for agriculture and livestock. The wildlife of these forests, from the world's smallest deer, the Pudu, to the Andean Bear, is threatened. Likewise, the temperate rainforests of New Zealand and eastern Australia have been greatly reduced, threatening kiwis of several species and other unique wildlife.

Tropical forests of many types, from lowland rainforests to dry deciduous forests and, in higher elevations, montane cloud forests, grow in a belt around the Earth's tropical latitudes. They teem with millions of species of insects, birds, mammals, reptiles and amphibians. The last 5 percent of Brazil's Atlantic coastal forest harbors South America's greatest primate diversity, with species ranging in size from tiny lion marmosets, weighing only a few ounces, to the Muriqui, or Woolly Spider Monkey, the continent's largest primate. All are now threatened with extinction. Madagascar's tropical forests echo with the calls of 33 species of lemurs, charming and fascinating primates that exist nowhere else but in these forests that are being cut for farm plots and charcoal. In Amazonian and Indonesian rainforests, literally hundreds of kinds of colorful parrots fly in noisy flocks, each with its own ecological niche of food type and habitat. Almost one-third of all parrots are now threatened.

A large percentage of tropical forests have been destroyed over the past century, with some areas, such as the Philippines, Thailand, West Africa, Andean countries, the Caribbean and, most recently, parts of Indonesia, experiencing almost total deforestation. The losses here have been dramatic, as Orangutans, Tigers, rare birds and two species of primitive rhinos add to these countries' endangered lists. The countries with the largest numbers of endangered birds, Indonesia and Brazil, have lost, or are in the process of losing, large tracts of tropical rainforest. Entire ecosystems are collapsing in the process. The great variety of fig trees of Southeast Asia depend on hornbills to distribute their seeds, but these birds are fast disappearing. Pollinating species like bats, small primates and birds are also in sharp decline as the rainforests are destroyed. Many are found only in a limited area, surviving in the remnants of these forests.

On the positive side, many large preserves have been set aside in South America to protect this diversity, and conservationists are working in other parts of the world to protect parks and help establish new reserves to prevent massive extinctions in these forests. Paper recycling and using substitutes for wood-based products are also conserving trees.

Activities

o Examine as many of the books listed below, showing the great beauty and diversity of forests, as possible. These include *Jungles; The Rainforests*, *A Celebration; The Life and Mysteries of the Jungle*; *The Living Wild; Hotspots. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*; *North America's Rainforest. The Endangered Paradise*; *Living Planet. Preserving Edens of the Earth*; *Ancient Forests. A Celebration of North America's Old-growth Wilderness*; and *The Enchanted Canopy. A Journey of Discovery to the Last Unexplored Frontier, the Roof of the World's Rainforests*. Also, read books on particular forest species, such as butterflies, birds, primates, bats or insects. Many are listed in the Books and Publications section. See films listed below and in the Video section of this book on forests, particularly threatened ones in Madagascar and other parts of the world, as well as films of endangered forest wildlife. This introduction is intended to create enthusiasm and curiosity as well as an appreciation of the wealth of plants and animals that are at stake as old-growth forests are destroyed.

o Select a forest from the list below to study its status and threatened trees and wildlife.
- United States southeastern Long-leaf Pine forests
- North American eastern hardwood forests
- North American temperate rainforests
- South American temperate rainforests
- Brazilian forests of Atlantic coast
- New Zealand or Australian temperate rainforests

- Madagascar tropical rainforest
- Hawaiian tropical rainforest
- Mascarene tropical forests
- West African tropical rainforests
- Andean tropical rainforests and cloud forests
- Central American cloud forests
- Colombian rainforests
- Caribbean tropical forests
- East African tropical forests
- Indonesian rainforests
- Philippine rainforests
- Indian montane forests of the Ghat region
- Himalayan forests
- Chinese tropical forests

o Read about this type of forest in *The Endangered Species Handbook* and in references listed in the Forests chapter and the Books and Publications section. Also consult the Internet.

o Describe the original extent of this forest several hundred years ago, and the present extent. (Collins 1990 and Mittermeier 1999a, cited below, are excellent references.) Explain how it has become threatened. For example, some forests have been gradually whittled away by cutting for firewood or land clearance, while others have been cut by corporate logging companies or government programs to establish large-scale agricultural farms. Still others have been officially conserved but, through failures in enforcement or misguided policies, their wildlife and trees have been lost.

o What species of wildlife and plants or trees have become endangered as a result of the destruction of these forests? Which species are unique to that forest region? Describe them.

o Select an animal or plant species that is threatened with extinction and write a short report about it, using the criteria in the project, "Profile of an Endangered Species." It can be a type of butterfly, orchid, ant, bird or mammal, for example. Write about the species in the context of its forest habitat, whether its habitat is being protected, and other threats to it that may include pollution, trade or competition with exotic species. As source material, consult this book, *Threatened Birds of the World, Walker's Mammals of the World*, and other references cited here or in the Books and Publications section of this book.

o By consulting books, such as *Hotspots* and other books listed below, list the threats to the forest you are describing and what is being done to protect the forest and its wildlife.

o Read the Forests chapter for information on the use of plants, such as kenaf, to make paper and building houses with little or no lumber. Discuss the role these measures could have in conserving forests. Write organizations, such as Earth Island Institute, for information.

Books and Publications
Films

Forests: Books and Publications

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Durrell, L. *State of the Ark*. Doubleday & Company, Inc., Garden City, NY.

Ellis, G. and K. Kane. 1991. *North America's Rain Forest. The Endangered Paradise*. NorthWord Press, Minocqua, WI.

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Forests: Films

The films below are reviewed in the Video section, which gives information on their distributors and more detail on their content. Also, films on individual forest species, such as Tigers, are reviewed, along with additional films on many of the subjects and regions above.

General films on rainforests: "Rain Forest" and "Exploring the High Frontier," both by National Geographic Society.
Temperate rainforests in US: "Ancient Forests,fl fiLast Stands of the Giants"
Temperate pine forest of US southeast: "Remnants of a Forest"
US National Forests: "Our Vanishing Forests"
Regional: "Amazonia: A Burning Question;" "The Decade of Destruction" (Amazon rainforest); "Korup--An African Rain Forest" (Cameroon); "Spirits of the Forest" (Madagascar); "Forest Primeval" (Part 3 of "Heart of Africa") (Democratic Republic of the Congo & area); "Animalai, India's Elephant Mountain" about the Indian Ghats; "Monkeys on the Edge" (Brazil's Atlantic forest); "Song of Protest," "Land of the Kiwi," and "Mountains of Water" (New Zealand).

Grasslands

Project Summary

The purpose of this project is to learn about the wild grasslands of the world, their wildlife and threats to them. One particular region will be selected and its original extent, wildlife, and present status will be described. The ways in which this grassland is being conserved or destroyed will be a major focus.

Background

Just a century ago, grasslands covered much of central North America, from southern Canada through Texas to northern Mexico, and from west of the Rockies east to Midwestern and northeastern states. Tall-grass prairie, with grasses up to 12 feet in height, grew from Ohio west to the Mississippi River area. This savannah grassland had groves of oak and other trees. It had extremely rich soil and was plowed by American settlers into farmland. Today, less than 1 percent of the original extent remains, making it an extremely endangered natural ecosystem. West of the tall-grass prairies, a mixture of tallgrass and short-grass prairies existed, and further west, short-grass dominated. The short-grass and mixed prairies have also been plowed for crops, but some sizeable areas remain, primarily kept as pasture for cows. These grasslands have been greatly altered, leaving few examples of the original ecosystems. Vast herds of American Bison once grazed throughout these grasslands, with prairie dog towns covering millions of acres in the short-grass prairies.

The savannahs of East Africa, grazed by a great diversity of hoofed animals, represent a classic example of grasslands that are still in natural, intact condition. Although under stress from growing human populations, large reserves and national parks protect much of this region. By contrast, the dryer grasslands of southern Africa have been severely damaged by the introduction of large numbers of domestic cattle and the fencing off of wildlife from waterholes and

prime grasslands to prevent the spread of hoof-and-mouth disease to cattle. This has resulted in a large decline in overall numbers of both herbivores and carnivores. This is a repetition of the overuse of the Sahara and Sahel regions to the north, centuries before, by great herds of domestic camels and sheep, turning grasslands into sandy desert. Ethiopia, Somalia and countries to the north and east of the Serengeti in East Africa's horn were once covered in lush grasslands. Wildlife species found only in this region became threatened when Europeans introduced livestock, which infected wild ungulates with rinderpest and other diseases, causing massive mortalities.

In vast steppes that once stretched from the Black Sea to western China, livestock now far outnumber native ungulates, such as the Saiga antelope, a species that once thundered in herds of millions. Overgrazing and plowing of this dry land for crops has further degraded it, causing massive dust storms, similar to those that resulted from plowing the American prairie in the 20th century. South America has extensive grasslands in Venezuela and south-central Brazil, many of which become wetlands during rainy seasons. In Argentina and Chile's Patagonian grasslands, rheas, deer, Guanacos and other wildlife once abounded. After centuries of overgrazing by sheep and cattle, this wildlife has declined greatly, and the grasslands are turning to desert. Australia's grasslands have also been converted to use by livestock, displacing the varied marsupials and rodents that once thrived here.

Preservation of grasslands and their wildlife is now taking place in many parts of the world, including the United States, southern Africa and Australia. Reserves of remnant grasslands, with their great diversity of wildflowers, grasses and other plants, are being set aside and native wildlife reintroduced. This trend may spread to parts of Asia as well, but the pressures of human populations requiring farmland and grazing for livestock may prevent restoration in most areas.

Activities

o Read "Epitaph for America's Lost Species and Environments" in Chapter 1 to learn about the travels of Lewis and Clark through these prairies early in the 19th century, followed by the extermination of the great herds of bison, deer and Pronghorn. Read the Grasslands, Shrublands and Deserts chapter with references cited for more information on North American and other grasslands around the world and their endangered species. Write a short paper describing the changes in grasslands in North America since colonial times and the effects on wildlife.

o Select a grassland from the following list to study its wildlife and present status:

- North America's Tallgrass Prairie
- North America's Short-grass Prairie
- Central Asia's Steppes
- Australia's Grasslands and Drylands
- Saharan and Sahel Drylands
- East Africa's Serengeti
- Southern Africa's Grasslands
- Horn of Africa's Grasslands
- South America's Pampas
- South America's Patagonia

* What species of wildlife, plants or trees have become endangered as a result of the destruction of this region's grasslands or affected by related activities, such as grazing and meat hunting, by herdspeople? Which species are unique to that grassland region? Describe them.

* Select an animal or plant species native to this region that is threatened with extinction, and write a short report about it, using the criteria in the project, "Profile of an Endangered Species." It can be a type of wildflower, tortoise, butterfly, bird or mammal, for example. Write about the species in the context of its grassland habitat, whether its habitat is being protected, and other threats to it that may include pollution, trade or competition with exotic species. As source material, consult this book, *Threatened Birds of the World, Walker's Mammals of the World*, and other

references cited here or in the Books and Publications section of this book.

* By consulting books such as those listed below, describe the threats to the particular grassland or dryland you have selected, and discuss what is being done to protect the natural habitat and its wildlife?

o Use this project as a model to study the status of shrublands and deserts, as described in the Grasslands, Shrublands and Desert chapter of this book, with the emphasis on desertification of drylands into desert through grazing, firewood gathering and other activities. See the reference list of the latter chapter for further reading.

o If you live within the range of these habitats, participate in a project to restore native plants to a grassland. Grassland birds have undergone drastic declines in the past decade, mainly through loss of habitat. Identify the grassland birds in your area and help in a project to obtain habitat for them, improve existing habitat or grow seeds of native plants for planting. Several source books supply information on mail-order nurseries that sell native plants and seeds. *Noah's Garden* has chapters entitled, "In Respect of Grass" and "To Plant A Prairie," which give very specific information about these habitats. The National Wildflower Research Center (2600 FM 973 North, Austin, TX 78725) supplies native plant bibliographies for each region and lists native plant associations. A book written by Lady Bird Johnson, who founded this center, and Carlton B. Lees, *Wildflowers Across America*, is a dazzling showcase of native wildflowers as well as an excellent source of information on these ecosystems. If you live near a shrubland or desert, plant native flowers and plants in your garden instead of grass to restore the ecosystem and conserve water. See the list of books below for instructions on planting desert and dryland gardens.

o If you live in an area where grasslands are mowed for hay, begin a public relations campaign to convince farmers to wait until after bird nesting season is over to mow. This would be in late July or August for most species of grassland birds. Consult reference books to determine the nesting times of grassland birds in your area. Such measures would be of great help to certain birds that have lost most of their natural grassland habitat. Make up posters that illustrate one or more of the following birds, and text describing their decline and need for undisturbed nesting habitat. In the East, the Bobolink, Grasshopper and Henslow's Sparrows and Bluebird, among others, will benefit. In the West, various species of Lesser and Greater Prairie Chicken, Sage Grouse and other bird species mentioned in the Grasslands, Shrublands and Deserts chapter are among these. Ask farmers and landowners to help preserve these birds and other wildlife by mowing practices. Have signs made that landowners could post on their property saying, for example, "Grassland Birds Protected Here." Publicize the campaign through letters to the local newspapers and speeches at local organizational meetings.

o Construct nesting boxes for Bluebirds and Purple Martins to be donated to landowners in grassland with scattered trees or bordered by woods. Instructions on how to make and maintain Bluebird houses can be obtained from the North America Bluebird Society, P.O. Box 6295, Silver Spring, MD 20906. *The Complete Birdhouse Book*, by Don and Lillian Stokes, also gives instructions on building and upkeep for both the Bluebird and Purple Martin houses. Films made by Don and Lillian Stokes include advice on planting for birds by species, such as hummingbirds and grassland birds; advice on how to construct, place and maintain bird nesting boxes is also given (CPTV Offer, P.O. Box 82, Hopkinton, MA 01748). The placement and maintenance of bird nest boxes should be long-term so that they may provide permanent nesting homes. It is important to keep records on the occupancy and breeding success of each box.

o Help native butterflies by planting wildflowers of species that are needed for their life cycle. The Monarch Butterfly, for example, requires Milkweed plants for feeding and laying its eggs. Learn about the species of butterflies and other pollinating insects in grasslands in your area, especially those in decline. For species listed on the US Endangered Species Act, all conservation projects should be coordinated with the US Fish and Wildlife Service and your state Natural Heritage Program (affiliated with the Department of Game or Wildlife in each state). Roadsides next to highways or in median strips and along country roads or railroads provide important habitat for butterflies, especially in areas where grasslands are disappearing. Contact your state and local transportation departments to obtain permission to plant wildflowers in these areas. The North American Butterfly Association (909 Birch St.,

Baraboo, WI 53913) provides information about helping butterfly habitat and butterfly watching, a new and fascinating activity for which there are guide books. *A World for Butterflies. Their Lives, Behavior and Future*, by Phil Schappert, is a primary source of information about butterfly life histories, habitats, conservation and threats. It also contains beautiful photography of hundreds of butterfly species worldwide. More information can be obtained from Dr. Schappert via the Internet: www.aworldforbutterflies.com. *Butterfly Gardening: Creating Summer Magic in Your Garden*, published by the Sierra Club, was compiled by the Xerces Society, a conservation organization for native American butterflies, in cooperation with the Smithsonian Institution. Be careful not to use commercial wildflower seed mixes that include species not native to your area or even to the United States. Certain exotic wildflowers, such as Purple Loosestrife, a European plant, are spreading in the United States, drying up marshes and crowding out native wildflowers.

Books and Publications
Films

Grasslands: Books and Publications

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The Complete Birdhouse Book
The Bluebird Book
The Bird Feeder Book.
Little Brown & Co., New York.

Grasslands: Films

All films mentioned below are reviewed in the Video section.

"Crane River" is a celebration of the huge flocks of Sandhill Cranes that migrate across North American prairies.
"Durrell in Russia" is a 12-part series which includes films on the Saiga, European Bison and grasslands of Russia.
"Emas. High Plain of Brazil" centers on this large grassland, surrounded almost entirely by agriculture that serves as an island for Brazil's unique grassland animals, including the Giant Anteater and Maned Wolf.
"Grasslands," a Canadian Broadcasting Company documentary, describes the biodiversity and ecology of North American grasslands and their destruction.

"Land of the Eagle," a series, concerns North America as it was prior to settlement by Europeans, with segments on the prairies and their wildlife.
"Mysterious Black-footed Ferret" focuses on this extraordinary and highly endangered prairie native, filming its graceful, sinuous movements and rapid leaps while hunting prairie dogs.
"Nature of Australia" explores the natural history of the continent in six parts, from its grasslands to drylands, how native wildlife has been affected and what ecological harm has been done by humans.
"The Saiga of Kazakhstan" chronicles the decline in the herds that numbered more than 1 million animals as a result of hunting, fencing off of grasslands and loss of habitat. They have disappeared from the center of their original range in Central Asia.
"Sea of Grass" (segment of "The Living Planet") is one of the parts to this BBC series that describes the evolution of various ecosystems of the Earth.
"The Tiny Carnivores" introduces one to Australia's small marsupials, many of which are nocturnal and endangered, driven from their habitats in grassland, savannah and desert by human activity.
"Vanishing Prairie," a Disney classic, shows the inside of a prairie dog burrow and the wildlife that teems in this habitat.
"Varmints" documents the decline of prairie dogs in the American West through systematic poisoning programs by federal, state and local authorities, placing them in endangered status, and explains their important role in prairie ecosystems.
"Wildebeest Race for Life" follows the trail of 1 million of these odd-looking ungulates as they migrate in a large circle around the Serengeti.

Aquatic Ecosystems

Project Summary

Aquatic ecosystems are the most varied of all ecosystems, ranging from freshwater ponds to rivers, lakes, saltmarshes, coasts, mangroves and coral reefs to open ocean. Although a single type of ecosystem will be chosen for the project, it is hoped that the reports will be presented to the class to acquaint students with the characteristics of as many of these habitats as possible. The project will consist of selecting a particular type of aquatic ecosystem that is threatened in a geographical area listed below. This ecosystem, the threats to it--whether through pollution, damming, diversion or other activity--will be described, including its wildlife. Also certain aquatic species that are in sharp decline will be among the subjects listed for special attention. The ways in which this aquatic ecosystem, species or group of species is being conserved or destroyed will be a major focus.

Background

The aquatic ecosystems of the world have never been more stressed and degraded. The rise in human population to more than 6 billion people by the end of the 20th century placed strains of overuse and pollution on the limited supplies of fresh water, leaving billions of people without adequate clean water supplies and creating rising tensions over water rights. In these conflicts, wildlife pays a high price, losing pristine habitat and becoming contaminated with toxic chemicals and oil spills that are killing wildlife around the world. Dams have endangered numerous fish by impeding their migrations, and developing countries have been damming their rivers at an increasing rate. Rivers that flowed swiftly become still ponds after damming, an alteration to which many fish cannot adjust. Many of these fish are also declining as a result of the introduction of non-native fish, which are out-competing them. The Nile Perch

was introduced as a food fish in Lake Victoria, and it has virtually eliminated hundreds of species of native cichlid fish, colorful and ancient species. The Colorado River of the US west has many dams on it, which have totally altered the river's flow patterns and temperature, endangering many fish that had evolved in the swift-flowing, silt-laden water. The most dramatic example of a dam endangering a wide variety of plants and animals, and dislocating 1 million people, is the Three Gorges Dam being built on the Yangtze River of China. It will almost certainly result in the extinction of the Yangtze River Dolphin, a very ancient freshwater species, the Yangtze Sturgeon and numerous plants that will be inundated by the waters. Although far upstream, it will also have the effect of drying up wetlands downriver and at the delta. With inadequate provision for sewage treatment for the millions of people and industry living alongside the new lake formed by the dam, the Yangtze is expected to become extremely polluted. Large dams inundate vast areas, displacing thousands of people from their homes and drowning rare trees, plants and wildlife.

Diversion of rivers for agriculture or water supply has left many riverbeds and deltas dry, causing entire ecosystems to collapse. An increasing problem with rising temperatures has been violent storms which cause severe flooding of rivers, made worse by the deforestation that robs hillsides and riverbanks of protective trees that absorb rainfall throughout the year and hold the soil in place. Lakes and spring ponds that dry up in the summer are also being filled in by developers and government projects, eliminating habitat for myriad aquatic creatures, from frogs and salamanders to turtles and water birds.

Overfishing, pollution and destruction of ocean environments have reached crisis proportions, with 70 percent of all fish caught commercially in depleted status or worse, including some of the most ecologically important species--sharks, tuna and others at the top of their food chain. Toxic chemical pollution has increased, especially in colder waters, where whales and other cetaceans are dying from massive build-ups of chemicals such as PCBs (Polychlorinated Biphenyls), pesticides, heavy metals and other toxins. Along the pristine coast of Washington state, Killer Whales are dying from these toxic chemicals, as are white Beluga Whales in the St. Lawrence River. A Sperm Whale that died recently of toxic chemicals had to be disposed of as highly toxic waste. Other waste in the oceans is killing wildlife. Abandoned driftnets drown thousands of birds, seals, sea lions and sharks, and fishing line entangles endangered Northern Right Whales and other wildlife, drowning them. Plastic sheeting, balloons, plastic from six-packs and other trash are killing seabirds, such as the long-lived and declining albatross, which unknowingly feed this trash to their chicks, killing them, or swallow the items themselves, later dying of blocked intestines. Collisions with ships and motor boats are causing large numbers of deaths in Florida Manatees and whales.

Coral reefs, the most beautiful and biologically diverse ocean ecosystems, are dying from many threats. Dynamite and cyanide used to kill and capture fish destroy the entire reef. Overfishing, pollution and silt that washes off nearby lands from agriculture and development can combine to kill a reef. Global warming causes coral bleaching that is affecting a growing number of reefs. More than one-third of all coral reefs are now dead or dying.

Wetlands have declined in the United States by 50 percent. This has resulted in more destructive floods and losses in fisheries production. Wetlands filter pollutants, and their reduction has lowered water quality. Elsewhere in the world, similar declines have taken place. Both fresh and saltwater marshes provide important benefits in cleaning water through a natural filtration system. In fact, the worldwide value of this benefit to the Earth and human society has been calculated at $1.7 trillion. Marshes also provide important flood controls by absorbing large amounts of water from nearby sources or rainfall, as well as a multi-billion dollar benefit of serving as nurseries for fish, shellfish and other wildlife. Traditionally, however, they are filled in for development, airports, seaports and other commercial uses which are considered to be far more beneficial to society. It is important to reexamine such an approach, especially in view of the tremendous costs of flooding in human lives and property and the decline in fish and shellfish harvests.

An atmospheric phenomenon caused, apparently, by CFCs, or chlorofluorocarbons, chemicals used in refrigeration and for other industrial purposes, is thinning the ozone layer, a protective shield that filters the sun's rays before they strike Earth. Large holes have developed over the Poles, especially the South Pole, allowing huge amounts of ultraviolet rays from the sun to enter the atmosphere, causing many cases of skin cancer in humans and

having unforeseen effects on animals with sensitive skin like frogs and salamanders. Frog species are disappearing at a catastrophic rate, especially those that lay their eggs in the open, exposed to the ultraviolet rays of the sun. Frogs are also suffering grotesque birth defects, which may be caused by pesticides or virus outbreaks. Frogs™ decline may be a warning sign that serious problems exist in the aquatic ecosystems of the world that will soon begin to affect human beings.

Activities

o Read the Aquatic Ecosystems chapter, which describes many of these problems in detail and parts of the world where large numbers of animals and plants are endangered. The references cited will provide more information.

o Select a species of wildlife or plant that has become endangered as a result of the destruction of aquatic ecosystems or related activities. Describe its status, threats to its habitat and what--if anything--is being done to prevent its extinction.

o Select an aquatic area from the following list to study its wildlife and present status:

- United States™ Colorado River
- Florida's Everglades swamp
- Rivers and wetlands of the US East and Southeast
- Russia's Lake Baikal
- Central Asia's Aral Sea
- East Africa's Lake Victoria
- Southern Africa's Okavango Delta
- Brazil's Pantanal wetlands
- Amazon River and its dams
- China's Yangtze River
- Australia's Great Barrier Reef
- Mississippi River Delta and adjacent waters

All are described in the Aquatic Ecosystems chapter. See also Video and Books and Publications sections.

o The following wildlife has become endangered as a result of the destruction of these aquatic ecosystems or related activities. Select one and discuss threats, species involved and conservation programs:

- albatross and other large seabirds
- frogs
- whales and dolphins
- sharks
- sea turtles
- penguins

o Select an aquatic animal or plant species that is threatened with extinction and write a short report about it, using the criteria in the project, "Profile of an Endangered Species." It can be a type of fish, frog, turtle, aquatic insect (such as a dragonfly), bird or mammal, for example. Write about the species in the context of its aquatic habitat, whether its habitat is being protected, and other threats to it, which may include pollution, trade or competition with exotic species. As source material, consult this book, *Threatened Birds of the World, Walker's Mammals of the World* and other references cited here or in the Books and Publications section of this book.

o Make comparisons between natural means of flood control, including marshes, beaver ponds and heavily forested stream and riversides, and artificial means, such as levees, dikes and canals. *Water, A Natural History*, listed below,

is helpful in pointing out the differences. Compare the cost and success of natural means of controlling pollution, such as sewage through marshes that filter waste, and artificial means through sewage plants. Individual homes in suburban and rural areas use septic tanks and cesspools to store sewage. In times of heavy rain, however, they often overflow into rivers, as do urban sewage plants. In many parts of the world, no sewage treatment exists, causing rivers and waterways near cities to become severely polluted. Some cities in California and elsewhere have constructed artificial marshes to filter sewage water, creating, in the process, wildlife havens. New types of toilets, known as compost toilets, are another less-polluting innovation. Read Chapter 9, "Aqueducts and Toilet Bowls" in *Water, A Natural History*, and write a short report on improvements needed in the present systems.

o Grassroots organizations throughout the world have been successful in restoring rivers and other aquatic ecosystems. Using a book, such as *How to Save a River. A Handbook for Citizen Action*, select a river, wetland, pond (including beaver ponds), lake or vernal pool (temporary wetland that dries up in the summer) to help preserve or clean up from pollution. Small projects can be of importance in conservation. For example, some high school classes in the Midwest sampled a nearby marsh for the types of frogs found there and discovered that the majority were deformed, having five or more legs, misplaced eyes or other grotesque malformations. The situation was given publicity, and research began on the causes. Pesticide contamination was considered the most likely cause, since water from the marsh used to grow frogs in captivity produced similar deformities. One organization, The Riverlands Conservancy, has helped purchase river habitat in Oregon, Missouri and Washington totaling 17,174 acres since 1993. Measuring pollution in local waterways is an excellent class project that can lead to environmental action on the part of state or federal authorities. Save Our Streams program, run by The River Network, headquartered in Portland, Oregon, and its sister organization, The River Clearinghouse, provide information to activists throughout the country on an 800 "hot line," using a database of volunteer experts who provide advice. The River Watch Network has been instrumental in helping communities monitor water quality in order to restore and protect rivers. (See *How to Save a River. A Handbook for Citizen Action* for more information and other organizations, which include American Rivers, the International Rivers Network and Riverkeepers, working to preserve aquatic ecosystems.) Using these examples, propose a class project to help conserve a local aquatic ecosystem**.**

Books and Publications
Films

Aquatic Ecosystems: Books and Publications

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Aquatic Ecosystems: Films
All films mentioned below are reviewed in the Video section.

General: "Acid Rain. Clouds with a Sulphur Lining" discusses the severe problem of acidification of rainwater caused by air pollution and its effect on forests and other environments. "Dead Ahead: The Exxon Valdez Disaster" is an examination of the 1989 oil spill in Alaska from many aspects. "Pollution: World at Risk" is a general look at various types of pollution and toxic chemicals and their environmental effects. "Vanishing Wetlands," produced by the Canadian Broadcasting Company, explains the ecological benefits of wetlands and threats to them. "The Wasting of a Wetland" focuses on the Everglades but describes the abuse of wetlands as it affects wildlife**.**

Ocean environments: "Cities of Coral"; "Coral Reefs. Rainforests of the Sea"; and "Jewels of the Caribbean Sea" all center on coral reefs. They show the great beauty and diversity as well as the threats to them. "Creatures of the Mangroves" and "Margins of the Land" (segment of "The Living Planet") treat the shoreline areas, and "Messages from the Birds" concerns the decline in shorebirds in North America. "The Open Ocean" (segment in "The Living Planet") explores the evolution of this habitat on Earth. "The Mirage of the Sea" discusses the overfishing and exploitation based on the assumption that there would always be plenty of fish. "Blue Whale: Largest Animal on Earth" is the first film to follow these giants in the ocean. "Desert Whales" are the Gray Whales that winter off Baja California, Mexico. "The Forgotten Mermaids" is a film about Florida Manatees. "Sperm Whales: The Real Moby Dick" gives glimpses into these deep-diving whales and discusses the fact that they have not recovered from whaling, with large males still very rare. "Colony Z" is about the very rare Yellow-eyed Penguin of the New Zealand region. "Whales Down Under" focuses on a population of newly discovered Southern Right Whales east of New Zealand, following them for a long period.

Freshwater environments: "Sweet Fresh Water" (segment in "The Living Planet") is an in-depth look at the planet's limited supply of water and the creatures who inhabit these environments. "Giant Otters" follows a boisterous group of these largest of otters in South America, discussing the causes for their decline. "Journey to Save a Crane" describes a project of the International Crane Foundation to preserve the endangered Siberian Crane through delicate negotiations with Chinese and Russian authorities. "White Water, Blue Duck" is a film about this threatened New Zealand duck and its remarkable adaptation to a very swift-flowing river. "Jewel of the Rift" (segment in "Heart of Africa" series) concerns Lake Victoria, its geology and the amazing, colorful fish native to it, which are now being eliminated by the Nile Perch. "Okavango: Jewel of the Kalahari" explores this huge wetland, second largest in Africa, set in the middle of a desert. "Amazon. Land of the Flooded Forest" illustrates how the flooding of the Amazon River each year nourishes a diverse ecosystem of fish, freshwater dolphins, fruits and trees. "Journey to the Sacred Sea" travels to Lake Baikal, where the unique fish and seals inhabit an extremely ancient and deep lake threatened by pollution. "Cadillac Desert" is an expose of the diversion of lakes and rivers to supply Los Angeles with its water supply at the expense of wildlife and the environment. "Prairie Waters" visits the potholes of Midwestern North America, temporary ponds and lakes that provide breeding habitat for millions of ducks and other birds each spring, yet are routinely filled in by farmers. "The Wild Colorado" is a thorough look at the geology and ecology of the Colorado River and the effect of dams on its wildlife and ecology.

Trade
Project Summary
To better understand the international wildlife trade in live animals and animal products, focus will be placed on one or more major categories of the trade. The major categories are: whaling, fur, reptile skins, Traditional Medicine products, fisheries, wild pets (including cage birds, lizards, turtles, snakes and frogs). Selection by a student of a species, group of species or general subject under one of these categories allows an overview that can be thorough and involve much research, or result in a short report. A classroom project could involve a subject such as Traditional

Medicine, in which groups of students would select individual species or groups of species, such as rhinos (killed for their horns), Tigers (killed for every part of their bodies), seahorses, snakes, turtles, monkeys and other primates and sharks. The reports would be presented together.

Background

Trade in live animals, plants and the products made from them has caused extinctions and has pushed many to the edge of extinction. At least 15 percent of highly threatened mammals and birds have declined as a result of trade, according to the International Union for the Conservation of Nature and Natural Resources (IUCN) (see Hilton-Taylor 2000). Internationally, billions of dollars are earned legally and illegally, and each year, more species become exploited. The trade is second only to the international drug trade in overall profits, worth an estimated $3 billion a year in protected live animals and animal products. As soon as one species becomes rare from exploitation and receives protection, the trade switches to a similar one, pushing it into threatened status. Much of this trade is for luxury products or to supply collectors and the wealthy who wish to own rare birds and other wildlife; wear the furs of endangered species, such as Snow Leopards or Cheetahs; purchase purses or clothes made from rare snakes or other reptiles; or consume luxury foods, such as endangered fish, whale and even Tiger meat. The wool of the Tibetan Antelope, the Chiru, ivory from elephants, the caviar of the endangered Beluga Sturgeon, rhinoceros horn and live Spix's Macaws, captured for collectors of rare animals, are worth far more than gold. The Traditional Medicine trade deals in a wide variety of animal products and plants and is a major factor pushing the Tiger, rhinoceros, seahorses and a host of other species toward extinction. For the majority of species exploited for this trade, substitutes exist or the products are not effective remedies. Ecological systems worldwide are being disrupted with the removal of predators and other keystone species, causing a loss of biodiversity.

This trade is taking place in spite of the landmark Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), enacted in the 1970s and now ratified by a majority of the countries in the world. It places animals at greatest risk of extinction on Appendix I, which prohibits commercial trade, and threatened species on Appendix II, which limits or controls trade on a species-by-species basis. CITES bans trade in species listed on either Appendix if the trade will be detrimental to the species' wild populations. In practice, many species that are threatened with extinction and listed on CITES Appendices are traded illegally or in countries which lack national legislation restricting wildlife trade. Although endangered spotted cat fur coats are no longer seen in New York City clothing stores, the fur trade continues to use the skins of rare cats and other wildlife, which are openly sold in many countries around the world. Enforcement funding is inadequate in the majority of countries, even the United States, where only 10 percent of shipments are inspected. Moreover, certain products, such as powdered rhino horn or Tiger bones, can be easily secreted in packaging while in transit. CITES has been an important deterrent to trade in endangered species, however, providing many threatened animals and plants with needed protection. Also, a growing number of countries have strict legislation prohibiting trade in protected species, including exports.

The methods used to capture and kill animals for the wildlife trade are often cruel in the extreme. Steel-jaw leghold traps and wire neck snares that cause great pain and injury produce pelts for the fur and bushmeat trades. Whales die from exploding harpoons thrust into their heads and bodies. Frightened live animals are crowded into cramped, dirty cages and transported to pet shops and laboratories, suffering high mortality along the way. Man's inhumanity to animals reaches an extreme in the wild animal trade.

Activities

o Read the Trade chapter in this book and other sources referenced.

o Select a subject among the following wildlife and plant trades for further study:
  - fur trade
  - whaling and sale of whale meat
  - sea turtles--trade in eggs, meat, shell and stuffed curios
  - fine wools--Shahtoosh from Tibetan Antelope and Vicuña

- bushmeat from endangered gorillas, chimpanzees, monkeys, turtles and other wildlife of Africa and Southeast Asia
- fisheries products--sharks for their fins and meat and caviar, for example
- reptile products for luggage, handbags and other luxury goods
- wild bird pets
- reptile pets, such as lizards, snakes and turtles
- fish for aquariums
- butterflies for collectors
- plants, such as orchids and cacti, for collectors

After reading about these trades in this book and other sources, write a report that discusses the following aspects:

- How many animals or plants are estimated taken per year for this trade?
- What species are they? What is their status in the wild?
- Where are the animals and animal products sold? Are they killed or collected in one country where they are protected and then sold in another?
- What controls exist to protect threatened and endangered species traded? Are they listed on CITES or the US Endangered Species List? Are they protected in their country of origin with high penalties for illegal take or killing, or are the penalties so low that there is an incentive to capture the species illegally? In India, for example, wildlife smugglers and killers of Tigers and other protected wildlife almost never receive jail sentences or large fines, while in China, the death penalty can result from killing a Giant Panda.
- What profits can be earned from sale of these animals or animal products? Find out the prices of expensive goods, such as Beluga or other Russian caviar, Shahtoosh and other items.
- What are the potential ecological effects of the disappearance of these animals? African and Asian Elephants are keystone species, distributing tree seeds, creating water holes and forest openings that benefit their ecosystems. Their disappearance from many areas has already had ecological effects. Find other examples, such as Tigers, which are at the top of their food chain; monkeys and other primates who pollinate flowers or distribute seeds; birds caught for zoos and collectors, such as hornbills, who distribute fig seeds; or animals that are important food items for wildlife.

o Traditional Medicine trade--a group project. Based on the information in the Trade chapter and the references below, divide the class into groups and have each group select from the various species used in this trade, such as Tigers and other wild cats, rhinoceros, monkeys, seahorses, musk and other types of deer, snakes, pangolins, bears of all species and rare plants. The information for each group to gather is the following:

- What is the extent of this trade? Are animals and plants being collected throughout the world to supply the trade?
- What percentage is sold in China, other parts of Asia or in

Asian pharmacies in other parts of the world?
- What prices are obtained for these animals at the level of the captor, the local markets, exporter, importer and retail sales? What effect is this having on the species? Will it become extinct if the trade continues at its present level?
- Is the trade legal in the animal's country of origin? Is the species listed on CITES or banned from importation or exportation? Is the species openly sold in some markets? Where and when?
- Are there education programs that are trying to stop the killing, marketing and purchase of these species or the over-harvesting of rare plants? What governments or organizations are trying to help these species through protection of habitat, bans on commerce or enactment of strong legislation to protect them?

o Enforcement of existing legislation is crucial to protecting threatened and endangered animals and plants. What state and federal laws ban the sale, killing and purchase of endangered species? How is evidence gathered for wildlife crime cases? How does CITES work?

o Visit stores that sell animal products and live animals.
- Fur and department stores with furs: List the kinds of animals used to make the garments being sold. It is required by US law that the species of animal and country of origin be listed on the label. List the ranched animals, such as mink and chinchilla, and wild-trapped ones, such as lynx, beaver and raccoon. Write down the number of coats and other garments of each type of animal, the date, the store and its address. Neither ranched nor wild animals are humanely treated prior to their deaths. Learn about the methods of killing of wild animals (types of traps, number of animals killed per country and US state) and the numbers and species of animals farmed. Contact the Animal Welfare Institute, the Humane Society of the United States and PETA for films that show the cruelty of trapping. Farmed animals are kept in tiny cages, where they become neurotic, and killing methods are unregulated.

- Visit department and shoe stores to determine whether reptile products are being sold. This trade kills millions of animals and threatens many species, as well as causing rats and other rodents they prey on to increase to pest proportions when too many snakes and other reptile predators are killed. List the species from which the item is made, if possible. Laws regarding labeling of reptile products are less strict than those regarding furs, and some do not list the species. If possible, determine if any endangered species are sold and how many items are being sold in your area.

- Visit pet stores to inventory reptile pets, such as iguanas, lizards, snakes and turtles. Find out how many are wild-caught, what species and whether threatened. Also visit pet stores to inventory their cage birds. Ask if the birds were taken from the wild or are captive-bred. In the United States, wild-caught parrot imports are allowed only for a few breeders, and parrots in pet stores should be captive-bred. Ask if the birds were bred in captivity. Many finches and other birds are also banned from importation. Obtain a copy of the Wild Bird Conservation Act and see

if any of the species listed as fibannedfl are being sold. If so, tell the store owner and report this to the US Fish and Wildlife Service Law Enforcement Division. Contact the Environmental Investigation Agency (EIA) for films that show the capture of wild birds in Senegal and Argentina and the cruelty involved in the cage bird trade. If any pet store is selling primates, find out the species. It may be endangered, as in the case of a Diana Monkey sold in a Long Island pet store a few years ago. Primates do not make good pets and should not be purchased. Many organizations receive unwanted primate pets to care for, after they have bitten their owners. Ask your local pet store to avoid sale of live animals. This is a trend in many pet stores that now sell only pet food, leashes, books and other non-living items. Patronize such stores. Contact your local humane society to learn of rejected wild pets and the difficulty in finding homes for them and recount these examples in a letter to your local newspaper, asking people not to buy wild-caught animals of any type.

o Attitudes are crucial to the protection of native wildlife by the people living within their habitat. Killing of animals for food and sale as pets has increased in recent years as international trade provides worldwide markets. It has become all the more important for wildlife to be valued and protected by people living in their range. Effective education is a key. A program in Saint Lucia, an island in the West Indies, is run by Paul Butler, working for the organization RARE. He has taught pride and appreciation of native wildlife and convinced the people living on the island to protect their native parrot, a species in high demand among collectors and numbering only a few hundred in the wild, as well as their forests and other wildlife (see reference below). The smuggling of the St. Lucia Parrot has virtually stopped as a result, and its forest is now protected as the habitat for this national bird. In the rainforests of the Congo, a Gorilla family being studied by a primatologist was filmed. In order to acquaint local people with these animals, the film was shown to them. They had considered these apes to be fierce, dangerous animals, worthy of being killed for the bushmeat market. When they saw the tender affection among family members and the playfulness of the young Gorillas, they were pleased and surprised, saying "They are like us!" They had the forest declared a protected reserve and now teach their children to protect these Gorillas. (This was filmed by Moses Films and shown on National Geographic Explorer, entitled "Living with Gorillas" in 2000.) Write a report about the need for similar programs and find out about others being conducted to educate people about their wildlife. Think of species that would benefit from such programs, and write a short summary of an education program you think would be effective for an individual species or group of species. For example, turtles are being heavily exploited for meat and the pet trade throughout the world, endangering many species. If they were better appreciated in their native lands, especially Southeast Asia, where tradition and folklore hold them in high esteem, their future might be brighter. Design a poster and educational brochure about Asian turtles that could be distributed in Viet Nam, Laos, China and other countries where turtles are being captured in enormous numbers.

o While great profits can be derived from the sale of wildlife, even greater ones can come from tourism. Elephants killed for their ivory bring the hunter a one-time profit of several thousand dollars, but tourism centered around elephants can benefit local people throughout the long life of the elephant, a life of some 60 years, totaling $100,000 or more. The capture of rare parrots, likewise, is far less profitable than ecotourism, which is worth 100 times or more the value of their sale in the pet trade. Whale meat is far less valuable than live whales that are whale watched. Whale watching now earns $1 billion per year worldwide from the 9 million people who take part in excursions in almost 90 countries, according to the International Fund for Animal Welfare. Think of other examples of non-lethal or non-invasive programs that benefit wildlife and ones that might be started to provide local people with income without harming wildlife. Another form of non-lethal business concerning wildlife involves the placement of videocameras in wild habitats, connected with the Internet. Internet users pay a small fee to see live views of the animal or scene, or to access the website for more films and information. South Africa's national parks are profiting from such a system, and the potential is great for other such videocamera placements. Videocameras can be solar-powered, as engineered by Daniel Zatz in Alaska, who has placed these cameras near bear feeding areas, with the images sent to a museum in Washington state (seemorebears.com). They also have the advantage of not injuring or invading the habitat of shy species which might be disturbed by large numbers of tourists. Think of species that might benefit from videocameras in their habitats. Examples might be wild parrots at their nests or Tigers filmed in national parks along trails.

Books and Publications
Films

Trade: Books and Publications

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Trade: Films
All films are described in detail in the Video section.

General: "The Business of Extinction," produced in 1977, is a classic film on wildlife trade and is extremely hard-hitting, showing smuggling and animal cruelty in the wildlife trade. "The Rangers of Nepal" profiles the bravery and dedication of Nepalese rangers who protect Indian Rhinoceros, Tigers, Asian Elephants and other animals from poachers. "Wildlife for Sale. Dead or Alive" is a Canadian Broadcasting Company film documenting the multi-billion dollar trades--legal and illegal--in wildlife that endanger thousands of species worldwide.

Ivory trade: "Echo of the Elephants," "Elephant," "The Elephants of Tsavo" and "Daphne Sheldrick and the Orphans of Tsavo" all deal with the slaughter that elephants endured during the 1980s and the effects on their populations and behavior. These sensitive and intelligent animals are traumatized when a family member is killed. The last film concerns the orphan elephants, tiny victims of the killing for ivory, affectionately cared for by Daphne Sheldrick in Kenya.

Fur and Traditional Medicine Trade: "Empire of the Red Bear" is a series about Russian wildlife that includes the discovery of two dead Siberian Tiger cubs who starved to death when their mother was killed. "Tiger. Lord of the Wild" profiles many of the activists trying to stop the trade in Tiger pelts and body parts in India and elsewhere.

"Giant Otters" was filmed in Guyana, one of the few places left where these animals can be seen because of their killing for fur throughout their South American range, which is discussed.

Whaling**,** Sealing and Sea Turtle Killing: "The Great Whales," "Return of the Great Whales," "Blue Whale: Largest Animal on Earth," "Sperm Whales: The Real Moby Dick" and "Whales Down Under" all discuss the effects of whaling on the great whales. The latter film focuses on the Southern Right Whale, a species heavily hunted and only beginning to recover 50 years after receiving protection. "Sea of Slaughter" is based on Farley Mowat's history of the decimation of wildlife along the North Atlantic coasts. Walrus, whales, seals, sea mink, seabirds and other species that teemed in these waters in colonial times were killed for market sales--several species to extinction. "Long Live the Turtle" is part of a series on Japanese wildlife. "In the Shadow of Fujisan" discusses Japanese killing of sea turtles and their trade in these animals, as well as whaling and dolphin-killing. "Ancient Sea Turtles Stranded in a Modern World," by the Sea Turtle Restoration Project of Earth Island Institute, chronicles the many threats to sea turtles, especially drowning in shrimp nets, urging remedial effort to protect them.

Cage Birds: "Bird Traffic" is an excellent expose of the illegal capture of Salmon-crested Cockatoos at the roosts in Indonesia, showing the trauma and cruelty of their caging and shipment to Singapore and other Asian markets, endangering the species. "Caribbean Cool" is a film about the work of Paul Butler in St. Lucia and other Caribbean islands to protect the native parrot and its habitat. Children are taught about the parrots and dress in parrot costumes, singing songs about these birds and other wildlife of the island. The parrot is the national bird and is given much publicity and positive attention on the island.

Predator Prejudice

Project Summary

The purpose of this project is to research the general subject of predator prejudice and its effect on predators in various parts of the world. Read the material below and the Persecution and Hunting chapter in this book. The subject in general or a particular predator which has become endangered as a result of prejudice and persecution will be selected for a short report, including information on past and present distribution, control measures taken and the present status of the species.

Background

In the United States, Grizzly Bears, Gray and Red Wolves were eliminated from 98 percent of the country south of Canada by European settlers in control programs using poisons**,** guns and traps. Today, through natural recolonization and reintroduction, these predators are reoccupying small portions of their original ranges. Unfortunately, outside national parks, these animals are encountering prejudice. Local livestock owners, whose ranches surround the protected national parks and forests, oppose their presence. Livestock owners near one Gray Wolf reintroduction site in Yellowstone National Park in Montana attempted unsuccessfully through a lawsuit to have wolves removed from the park. Wildlife research over the past century has found that wolves rarely kill domestic livestock, and their predation on deer, elk and other ungulates keep these species strong and healthy. Grizzly Bears are mainly vegetarian, with occasional predation on small rodents or the calves or fawns of elk or deer, yet they have been hunted out of all but about 1 percent of their original range in the western United States south of Alaska.

Predator prejudice is common throughout the world wherever livestock is grazed in large numbers. In Ethiopia in East Africa, the Simien Wolf, a small canid that preys mainly on rodents, has been killed off by livestock owners who mistakenly believe them to present threats to their sheep and cattle. The species is near extinction. Likewise in South America, Europe and Asia, predators have been heavily persecuted, with wolves, bears, big cats and others eliminated from areas near human habitation and many wilderness areas.

Seals, sea lions and otters are also the object of prejudice from fishermen who believe that they take too many fish. In

fact, they often prey on fish that are not taken for human consumption, many of which are predators of food fish. The Caribbean Monk Seal was persecuted to extinction, and its close relative, the Mediterranean Monk Seal, is now critically endangered as a result of killing by fishermen. Its remaining populations, numbering fewer than 1,000 animals, hide in caves along the coasts. Sea otters eat invertebrates that eat kelp and sea grass, thereby playing a key role in maintaining these ecosystems in which fish and shellfish flourish, but abalone fishermen consider them unwanted predators.

Birds of prey have also been persecuted as threats to livestock or because they competed for the same food as humans. The Bald Eagle was killed for a bounty in many parts of the United States because it fed on fish, causing fishermen to believe that it was an unwelcome competitor. Hawks and eagles around the world are shot and poisoned by ranchers and others, reducing many species to endangered status. In some areas, birds of prey are shot on sight. Legal protection for these birds has only recently been enacted in the United States, but many other countries fail to accord protection. They have an important ecological role to play by preventing rodents, snakes and other species from multiplying to pest proportions. The majority of species specialize in killing rodents, which helps farmers raising and storing grains.

Likewise, bats prey on insects and are important pollinators of plants, but they are persecuted in most parts of the world.

Snakes are also important predators of rodents, yet they, too, are routinely killed around the world. They are either considered pests or inspire great fear that they might present a threat to human beings. Snakes tend to be afraid of people, who are not their natural prey, and if left alone, will not attack.

Crocodiles perform a useful role in preying of overpopulated fish, yet they are killed as potential threats or for the leather trade. A majority of crocodile species are now endangered.

Activities

o Research: Using the sources listed in the Persecution and Hunting chapter, and others listed below, as well as those available in your library and through computer on-line searches, learn about the subject in general. Consider the following aspects of the issue:

1. Laws have been enacted since the Middle Ages in Europe encouraging the killing of predators and even punishing those who did not kill and deliver their hides to authorities. Many of these laws have been altered over the years and now remain in the form of bounties paid for pelts, and regulations permit and encourage persecution of predators. Are there state laws that allow persecution of predators, including endangered species? (Read the US Endangered Species Act and the Marine Mammal Protection Act to find examples of legalized killing of species considered predators of livestock or fish.)

2. What attitudes prevail in various parts of the world toward predators? While negative fears and hatred dominate in many areas, trends are changing in many countries. North American native tribes traditionally revere predators and incorporate them into their folklore. Europeans settling America had an opposing view, instituting predator control programs. What is unusual about the legal status and attitude toward the Gray Wolf in Italy? (See Persecution and Hunting chapter.) What happens to endangered Cheetahs when white ranchers who hate predators take over land in Namibia and South Africa? What education programs are taking place to change prejudices? The reintroduction in the United States of both Gray and Red Wolves was a result of this new view and the application of the US Endangered Species Act, but education programs have had mixed success. In some areas, such as Yellowstone National Park, however, tourists are coming in large numbers, spending money in local towns, and watching the Gray Wolves in an open environment considered the best "wolf watching" area in the world. Could tourism help save predators? The survival of predators depends entirely on attitudes of people living in their habitats.

3. Biological Studies: Studies on Gray Wolves in Alaska in the 1940s by Adolph Murie began a major change in

knowledge of these animals and their relations with their natural prey that overturned previous misconceptions, many of which assumed that they were destructive to their prey. These studies have been augmented by other biologists on various predators throughout the world, confirming the important and positive role that predators play in ecosystems. What studies can you find that examine the biological role of predators of various types, including birds, fish (such as sharks) and reptiles (such as snakes and crocodiles)?

4. Economic Damage: Control programs against predators are based on real or assumed damage to livestock or other property or assets, but they have rarely been based on fact. Exaggeration and fear have distorted estimates of actual losses to predators. Moreover, the ranchers or herders tend to release their livestock into the wild without guard dogs or other protection. When their animals are found dead, predators are blamed, when proof is often lacking. When livestock is guarded by dogs or fences, or housed in buildings or pens at night and when giving birth, mortality is usually very low. Unfortunately, US government programs, such as the Animal Damage Control (ADC) Division of the Department of Agriculture, routinely trap and poison hundreds of thousands of animals each year without proof of their predation on livestock. Contact the ADC and ask how many traps, how much poison and how many animals of all types have been killed in recent years. Also ask for the numbers and species of no-target animals, such as endangered Grizzly bears, Bald and Golden Eagles and other wildlife, taken in these programs. Ask the ADC how it avoids killing endangered animals? How much is spent on these programs per year, and what alternative programs could protect livestock in non-lethal ways, including guard dogs or other guard animals, such as llamas and donkeys, and by providing information on protecting livestock for far less money?

o Reports and Discussion: Select the subject of predator control in general for a report based on the information you have gathered in accordance with the categories above. Discuss this issue in class.

o Select a particular species that has been persecuted to endangered or threatened status by predator control programs. What was the original range of the species? What is its present range? What are the natural prey species of the animal and its habitat? When did control programs begin to eliminate the species and what were the reasons on which they were based? Was the species gradually, or rapidly, reduced in both numbers and range? Were control methods directed at adult animals only or on the young, such as killing pups in the den? What is the natural behavior of the animal in terms of its social nature with others of its kind, number of young, number of breeding adults in a group, whether it is solitary, and whether it can easily recover its population once control is stopped or tends to decline to extinction? What are the attitudes of the people who live within its habitat? What is being done to help the species? What do you think should be done to prevent its extinction?

o Conservation: Describe various means of protecting predators that are persecuted. For example, bats have been conserved through education programs in local communities and schools about their ecological role and how to bat-proof buildings. Ecotourism is another means of protecting bats, since their flights at dusk can be spectacular. The economic value of predators in controlling insects or rodents, for example, is an important argument in their favor. Many approaches are needed, depending on the attitudes held by the local people, the type of damage alleged and the economic factor. In some cases, the same species can be reviled in one part of the world and admired in another. The Gray Wolf is now a valued and protected predator in a growing number of countries, but in Russia and other countries, it is still tainted by folklore that bears no relation to fact. Make recommendations for the conservation of the Gray Wolf or another species in a country where it is persecuted. Write a brochure and design a poster for a species of your choice that would educate the public about why this species should not be persecuted.

Books and Publications
Films

Predator Prejudice: Books and Publications

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Predator Prejudice: Films
All films are described in detail in the Video section.

Wolves: "Crying Wolf," "Wolf" (Spain), "Wild Wolves" (general), "Return of the Wolves" (Yellowstone National Park). All discuss the persecution, disappearance from large portions of its original range, and facts about the Gray Wolf's true ecological role and behavior. "Wild Dogs of Africa" is a sensitive portrayal of these endangered canids, including discussion of their persecution by ranchers, especially in southern Africa.

Bears: "Grizzly and Man--Uneasy Truce" (US persecution); "Grizzly Bears: Losing Ground" (British Columbia, Canada). These two films show the extreme ignorance and fear with which these bears are seen in North America, resulting in their killing for presumed threats and a lack of commitment on the part of the public and some officials to preserve the species.

Seals: "Orphans of Time" concerns the two surviving species of monk seals, the Mediterranean and the Hawaiian, both of which are highly endangered. "Seals--the Salmon Eaters," a film about seals in the Pacific Northwest (primarily Washington state) describes the intense hatred felt by fishermen toward seals and their desire to kill large numbers of them to increase the take of salmon.

Birds of Prey: "Anna and the Honey-Buzzards" is an inspiring film about a woman who has protected migrating birds of prey in southern Italy from being killed illegally by hunters who shot them from bunkers on hillsides. She has been joined by others who help her patrol the area since the film was made. "Eagles: The Majestic Hunters" is a beautiful film about these superb hunters and their life histories. It includes shocking footage of persecution of eagles in various parts of the world where they are killed and nailed to fences or poisoned.

Snakes**:** "Snake" is an excellent film to dispel irrational fears about snakes, 85 percent of which are harmless to humans, and to show their value in controlling rodents and other snakes.

Bats: See film list at end of "Bats: Ecologically Important Mammals" project.

Saving the American Elm and Chestnut Trees
Project Summary

This is an action-oriented project in which students or individuals obtain seedlings of these endangered trees and plant them to help restore the species, which were once widespread. For those living in areas outside the range of these species in Eastern North America, other threatened trees may be planted.

Background

Both the American Chestnut and the American Elm have been decimated by diseases brought to the United States on wood or trees. Millions of these magnificent trees have died, but within the past decade, plant geneticists have produced disease-resistant types. The Elm Research Institute distributes seedlings grown from trees that have natural resistance to Dutch Elm Disease and have survived exposure to it. The tree that is cultivated by this institute is called the American Liberty Elm, and since 1983, more than 250,000 seedlings have been distributed to organizations, such as the Boy Scouts of America and others, who grow them from seedlings, then sell them to local towns, public parks and organizations for planting. The organization hopes to bring back the American Elm to Main Street America. The Elm Research Institute also provides advice on saving diseased elms. One teacher in Michigan organized local neighborhood groups who located diseased trees and succeeded in treating them to prevent their deaths.

The American Chestnut, a massive tree of eastern forests, made up about one-fourth of the original eastern forests in colonial times. It provided nuts that were fed on by populations of the now extinct Passenger Pigeon, American Turkeys, Black Bears, squirrels and other wildlife. These trees grew to heights of 100 feet or more and had deeply furrowed trunks, earning them the name "Eastern Redwood." Their near-extinction has been catastrophic to forest ecosystems. The Chestnut Blight that attacked them was first seen in 1904 on American Chestnut trees lining avenues near the Bronx Zoo, and apparently entered the country on another species of chestnut tree imported for botanical purposes. Like Dutch Elm Disease, this disease cuts off nutrients and water, gradually killing the trees. It has killed almost all American Chestnut trees in the east, and only a hundred or so remain in southern Canada. Some trees that were planted outside the natural range, such as in Oregon, survive. The stumps of American Chestnuts still produce sprouts that can grow up to 20 feet tall until they die from the disease.

Old-growth Longleaf Pine forests once covered millions of acres in the Southeast, with one of the world's richest diversity of forest floor plants and native wildlife, including the Ivory-billed Woodpecker. These forests have declined to 2 percent of their original size, and many of their former denizens are endangered or gone. The Southern Live Oak, a magnificent semi-evergreen tree that has a massive, spreading crown and twisted branches, has declined in many areas within its natural range. These native trees should be brought back through massive planting programs. In more Western areas, Redwood, native oaks and many types of pines and conifers have declined from former abundance and should be replanted.

Activities

o Help conserve endangered trees, such as the American Elm. Plant American Liberty Elms if you live in eastern North America. The Elm Research Institute will send an application to those who wish to receive 500 to 1,000 free elm seedlings. Teachers who wish to participate in the program must pledge several years commitment in order to care for the trees prior to their sale. The trees are guaranteed if properly maintained, and the Elm Research Institute will replace any trees that die. This is potentially a fund-raising program because the trees can be sold after a few years of care. The Elm Research Institute can be contacted at 1-800-FOR ELMS; Fax 603-358-6305; website: http://www.forelms.org.

o Plant American Chestnut trees if you live in the range of the east where this tree once grew. The American Chestnut Foundation was formed in 1983 to save this species through selective breeding of resistant strains. At present, they have succeeded in growing resistant trees and are developing seeds from these trees. They distribute kits of resistant seeds, which can be grown in one™s back yard, for $50. When they are old enough, they can be pollinated with pollen from blight-resistant trees being cultivated in Virginia. This is somewhat more complex than the growing of American Elms, but for a high school class, it would be an excellent way of learning about plant reproduction while helping to save an endangered native tree. A 17-year-old resident of Somerville, New Jersey, Timothy Van Vliet, is an enthusiastic supporter of the program and has grown a number of Chestnut trees in his back yard, one of which is

10 feet tall. With more people like Timothy Van Vliet, the American Chestnut may return to its former abundance. The American Chestnut Foundation can be contacted at P.O. Box 4044, Bennington, VT 05201, or telephoned at 1-802-447-0110. Membership in the organization is $40.

o Plant other threatened native trees. Those who live in western North America can help a rare or declining species of tree. Contact the Redwoods National Park (1111 Second St., Crescent City, CA 95531; and the Save-the-Redwoods League (114 Sansome St., San Francisco, CA 94104) for information on obtaining seeds and seedlings. If one lives in the Pacific Northwest, native trees, such as Western Hemlock, Sitka Spruce and Western Red Cedar, have been reduced by 95 percent because of logging. Replanting these magnificent trees will help to bring back these forests and provide habitat for the threatened Northern Spotted Owl, Marbled Murrelet and other native species. Help protect the stands of these forests that remain by contacting organizations such as the Native Forest Council (P.O. Box 2190, Eugene, OR 97402); Save America's Forests, Washington DC (202-544-9219); and The Nature Conservancy (1815 N. Lynn St., Arlington, VA 22209; (703-841-5300).

Read "Smiles of Vanished Woods," Chapter 11 of *Noah's Garden. Restoring the Ecology of Our Own Backyards*, by Sara Stein, which discusses the importance of planting only native trees and the threat of exotic species, such as the Norway Maple, which can crowd out indigenous species. This book also stresses the importance of preserving old trees with hollow trunks and snags that wildlife can use and of planting understories of native bushes that hundreds of species of wild animals use for shelter and feeding.

Books and Publications

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Bees and Other Pollinators

Project Summary

Study the behavior of bees, using written materials, films and observations of actual beehives. Learn about plants that would become extinct without pollination by bees and what species of bees are indigenous to your area, especially those that are rare or declining. Learn what plants and habitats these species require and, if possible, plant their preferred flowers and erect a bee house.

Background

Many native bees in North America are important pollinators. A growing number are becoming rare as a result of

pesticides, competition with non-native bee species and destruction of natural habitats. Very few types of bees sting humans. There are 500 species of native bees in New England, for example, but the most commonly seen bees are the European honeybees used to pollinate orchards and other crops. Some native bees are green, blue or red, and many are as small as flies. Others are twice the size of bumblebees. A few are nocturnal.

The communication system bees use to identify sources of nectar and pollen to one another was first discovered in European Honeybees (*Apis mellifera*). When one bee locates a source of food, such as a flowering tree, it returns to the hive and through a complex series of movements with its feet, called dances, communicates to the other bees the location of the food source. The type of dance performed by the bee indicates the distance from the hive to the pollen and nectar. This system of communication involves a highly sophisticated integration of perceived and memorized information and was first discovered by an Austrian scientist, Karl von Frisch, a world-renowned animal behaviorist. He wrote two books on his discoveries: *Bees, Their Vision, Chemical Senses and Language*; and *The Dance Language and Orientation of Bees*. (See Reference list below.)

Methods

Learn about pollinators and their ecological importance and behavior. *The Natural History of Pollination*, by Michael Proctor, Peter Yeo and Andrew Lack, describes bee communication in terms of the extreme importance of bees as the pollinators of many native plants. Consult various reference books that describe bee behavior in detail. "Dancing the Good News" in the book, *Alien Empire. An Exploration of the Lives of Insects*, by Christopher O'Toole, clearly illustrates this remarkable phenomenon. This book is a companion to the excellent television series of the same name shown on Nature, the PBS program produced by WNET and filmed by BBC, which shows the dance of the honeybees as well as the behavior and ecology of many insect pollinators.

Activities

o Take a field trip to see a beehive. Teachers may contact local nature education centers, Audubon societies, state Natural Heritage Programs and US Department of Agriculture extension services to learn about local bee hives that could be visited.

o Contact the Natural Heritage Program connected with your state wildlife department, and find out which species of wild bees live in your area and which species are rare or declining. Discuss these species and what can be done to help them. What plants would become extinct if pollinating bees were to disappear? (*The Natural History of Pollination* is a good source of information for this subject.)

o Plant flowers and flowering trees that attract native bees. Find out which plants are preferred by bees in your area. Do not use pesticides or herbicides of any kind.

o Erect a beehouse in your back yard to attract native, stingless bees. A few holes drilled in scrap lumber and mounted under the eaves of a house, or some paper straws glued into a milk carton and placed on a tree branch, will entice native bees. To attract the large and colorful Bumblebees, build a house such as the one described in *Attracting Backyard Wildlife*, by Bill Merilees.

o Using *The Forgotten Pollinators*, by Stephen L. Buchmann and Gary Paul Nabhan, *The Natural History of Pollination* mentioned above, and other references on insects listed in the Books and Publications section of the Appendix of this book, select one or more pollinators, whether butterflies, ants or other insects, birds, bats or primates. Learn about these pollinators and which plants they pollinate, especially those that are threatened with extinction.

o By consulting the books mentioned above, the main text of *The Endangered Species Handbook*, and books listed in the Books and Publications section of this book, learn about the importance of pollinators in maintaining the world's ecosystems and how crucial it is to protect pollinating animals. Describe a pollinator or group of pollinators that are crucial to an ecosystem. For example, read the section in the Forests chapter in *The Endangered Species Handbook*

concerning tiny wasps that pollinate a wide variety of figs which, in turn, nourish hundreds of species of wildlife. Learn about mammals, such as bats that pollinate many types of plants, through descriptions in this book and others listed in the project, "Bats, Useful Insectivores and Pollinators." Find an example of a species of plant that has lost its natural pollinator through extinction and now exists only through human intervention.

o The economic importance of pollinators has been calculated in several books and studies. In *Nature's Services: Societal Dependence on Natural Ecosystems*, edited by Gretchen Daily, for example, the role of wild pollinators, such as insects and other animals, is valued at $117 billion worldwide. This means that the wild bees, ants and other species that pollinate commercial crops, such as fruit trees and wild plants, perform tasks that are worth $117 billion per year to the world's economy. The authors of *Forgotten Pollinators* estimate that pollinators save farmers in the United States an estimated $1.6 billion annually. Select a farm crop and find out from local US Department of Agriculture offices whether wild species of insects or other animals pollinate it. Through data from the US Department of Agriculture and almanacs, calculate the value of this crop and the losses to farmers should the wild pollinators disappear.

o Wild pollinators are in decline in many areas as a result of heavy pesticide use, which kills insects and other wildlife, and habitat loss, as in the cutting of forests, which causes declines in bats, tropical birds and insects. The Forests chapter discusses this in detail. Write a report on this problem, giving as many examples as possible of the loss in these essential species and the types of threats that pollinators face.

o Select a pollinator**,** such as a type of butterfly**,** and learn about what plants it pollinates. Does it pollinate a single species of plant or many species? Where does it live? What is its status? If threatened, how can it be helped?

Books and Publications

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Films

"Alien Empire. An Exploration of the Lives of Insects." 1995. PBS. WETA. 1 hour.

"The Private Life of Plants." 1995. TBS/BBC. 6 hours. (Part 3, "The Birds and the Bees," concerns pollination.) Available from Discovery Channel School: 888-892-3484; www.discoveryschool.com.

Learning Animal Anatomy Without Dissection

Project Summary

Learn about animal anatomy in non-lethal ways. New communication technology may provide better knowledge about anatomy, through videos and virtual learning, than does dissection. Learn about these new resources and discuss their use in the classroom.

Background

In a growing trend, biology classes are being taught about the anatomy of frogs, cats and other animals from CD-ROM software, such as "Digital Frog and Cat Lab**,**" rather than killing live animals for dissection or dissecting dead animals. An estimated 6 million vertebrates, half of which are frogs, are dissected each year by high school students, who are often so upset by the experience that they turn away from future science courses. Such school projects are inhumane, often requiring that frogs be killed by the student, for example. Moreover, frogs are in decline in the wild from a variety of causes, including the capture for such dissections. Their populations need protection. Many of the cats killed for use in high school dissection had been house pets that were illegally caught and sold to animal dealers in the United States and Mexico. Humane organizations have been promoting non-lethal substitutes for many years.

Activities

o Find out if your state's education department allows use of alternatives to animal dissection in classrooms.

o Review a copy of "Digital Frog and Cat Lab" or another software from the organizations below. The National Geographic Society sells various films, film-strips and other materials on animal anatomy. The lessons include function, taxonomy and structure. The Society's "Educational Services" catalog lists these products (P.O. Box 98019, Washington, DC 20090; 800-368-2728; www.nationalgeographic.org).

o Contact the American Anti-Vivisection Society (Suite 204 Noble Plaza, 801 Old York Rd., Jenkintown, PA 19046, 215-887-0816), which publishes the brochure "Animals in Education: An Outline for Student Activists" and distributes audio-visual materials. Also contact the American Fund for Alternatives to Animal Research (175 West 12th St., Suite 16G, New York, NY 10011, 212-989-8073) and the American Society for the Prevention of Cruelty to Animals (ASPCA) (441 East 92nd St., New York, NY 10128, 212-876-7700), which publishes the pamphlet, "ASPCA Guidelines for Student Experiments Involving Animals." The Animal Legal Defense Fund (1363 Lincoln Ave., San Rafael, CA 94901) has a "Dissection Hotline": 800-922-FROG, and publishes the brochure "Objecting to Dissection: A College Students' Handbook." The Humane Society of the United States (2100 L St., NW, Washington, DC 20037, 202-452-1100) publishes the brochure, "Does the Idea of Dissecting or Experimenting on Animals in Biology Class Disturb You?" Also, the National Anti-Vivisection Society (53 West Jackson Blvd., Suite 1550, Chicago, IL 60604, 312-427-6065) publishes "Reverence for Life: An Ethic for High School Biology Curricula" and "School Project Packet." The Student Action Corps for Animals (P.O. Box 15588, Washington, DC 20003, 202-543-8983) is dedicated to empowering young people in high school to work effectively for animal rights and acts as a communication network; it began the national "Say No to Dissection" campaign in 1984 and publishes *SACA News* and brochures such as "Say No to Dissection," "Suggestions for High School Student Animal Rights Groups" and "1-0-1 Non-Animal Biology Lab Methods."

Attitudes and Ethics

Project Summary

Examine the list of principles related to the treatment of animals entitled "An Animal Bill of Rights" (see below) and consider how these principles relate to declining and endangered species. Suggestions are given on how to use this document for classroom discussion or reports on endangered species.

Background

Our attitudes about animals have undergone radical changes in the past few decades. For most of human history, people have believed, like the philosopher René Descartes, that animals were merely machines, blindly obeying instincts. The opinions of many people have been greatly changed by the results of work with animals, for example, the intelligent Chimpanzees who make tools and exhibit many of the same emotions that humans have, such as fear, love, anger, joy and even despair. Elephants have also shown extraordinary qualities of altruism, and many examples of their intelligence have been documented by zoologists. Whales and dolphins, too, have been shown to be intelligent and extremely devoted to one another.

Attitudes towards animals are also changing rapidly as a result of films and books and closer contacts with domestic cats and dogs. The popularity of house pets, with whom we form strong bonds, has encouraged a growing number of people to regard animals as having many of the same emotions as humans, and their friendship and loyalty toward us have been an inspiration to many. The popularity of nature films and books has educated the public to have a greater affection and respect for wild animals and a desire to protect and appreciate them. Still, many people treat animals as having neither sensitivities nor even the ability to feel pain. Fur trapping, research involving cruel experiments on animals, and baiting or attacking animals as an amusement are examples of a lack of compassion. A comment by a Canadian forester represents such a point of view that is, fortunately, disappearing: "Our instinctive attitude toward other species seems to range from indifference to antipathy . . . Concern for other species, particularly for those that have no immediate economic value to us, is a learned response, one we still struggle with" (Don Gayton, British Columbia Forest Service, "Terms of Endangerment" article in *Canadian Geographic*, May/June 1997).

Having a set of values and principles is a logical step in reevaluating how we treat animals--domestic and wild. The famed British zoologist Desmond Morris, in his book *The Animal Contract* (Warner Brothers, 1990), recommends 10 principles that human beings should adopt in their treatment of animals. This book discusses in detail the basis for the principles and gives many examples of our treatment and mistreatment of animals. He states that brutality to animals affects all our conduct and dealings with humans as well, and that a culture that is sympathetic to animals is a culture that is sensitive and caring in all respects. Moreover, he believes that a culture that feels a kinship with animals will be a culture that keeps faith with its roots in recognizing that humans are also animals, relatives of other species. These principles, as related to threatened species, are discussed below. They could also be used as interesting subjects for classroom discussions or for reports.

An Animal Bill of Rights

1. No animal should be endowed with imaginary qualities of good or evil to satisfy our superstitious beliefs or religious prejudices.

2. No animal should be dominated or degraded to entertain us.

3. No animal should be kept in captivity unless it can be provided with an adequate physical and social environment.

4. No animal should be kept as a companion unless it can adapt easily to the lifestyle of its human owner.

5. No animal species should be driven to extinction by direct persecution or further increases in the human population.

6. No animal should be made to suffer pain or distress to provide us with sport.

7. No animal should be subjected to physical or mental suffering for unnecessary experimental purposes.

8. No farm animal should be kept in a deprived environment to provide us with food or produce.

9. No animal should be exploited for its fur, its skin, its ivory or for any other luxury product.

10. No working animal should be forced to carry out heavy duties that cause it stress or pain.

Source: *The Animal Contract* by Desmond Morris. Warner Books. 1990.

Although many of these principles relate to domestic animals and can be discussed in another setting, others relate to our treatment of wildlife, including endangered species. Discuss the way in which these principles apply to threatened species.

Activities

o Principle number 1 could apply to wolves and bats, which are considered by many societies and individuals to be evil. Read the Persecution and Hunting chapter in this book for other such cases and consider the implications of such prejudices on the survival of many animals.

o Principle number 2 can also be applied to endangered species in that Lions (now considered Vulnerable species), Tigers, chimpanzees and elephants (all Endangered species) are trained to perform tricks in circuses that degrade them. Brown Bears used by gypsies in Europe and Asia are another example. They are dragged about by leashes attached to nose rings and trained to perform extremely unnatural acts, such as "dancing" on their hind legs. Discuss this principle and learn how circus animals are trained and how they are treated. Contact organizations such as PAWS (Performing Animal Welfare Society, P.O. Box 849, Galt, CA 95632) or the Animal Welfare Institute to learn more about this.

o Principle number 3 can apply to zoos that house endangered species. If the captive conditions do not allow the animals adequate physical and social environments, they would be considered to be violations of these principles. Examples might be the keeping of an elephant, a highly social species, by itself, in a small enclosure without water to bathe in or space to exercise. These animals are also chained at night in many zoos. Are there animals at your local zoo kept in such conditions?

o Principle number 4 can be applied to wild pets of many species that are kept in unnatural conditions. Tigers and other big cats, wild-caught parrots and many reptiles and amphibians are kept in peoples' back yards in cages or in indoor conditions that are highly unhealthy or psychologically traumatic for the animal. Many states ban various wild pets for this reason. Read the Trade chapter in this book for more information on wild pets and zoos. Find out the laws of your state or country regarding the keeping of exotic pets, especially endangered species.

o Principle number 5 is an extremely critical one in relation to endangered species. Although the US Endangered Species Act specifically addresses the issue of driving species to extinction as unacceptable, the law has been weakened by its opponents and faces further weakening. Moreover, only listed species receive such protection. Many threatened and endangered species that are not listed on the US Endangered Species Act receive no legal protection. In other countries of the world, such as Canada, no law prohibits driving a species to extinction or protects endangered species. Human overpopulation is a major cause driving species to extinction. This is an extremely important moral dilemma, one that is being faced by countries such as Indonesia, which has relocated people from overpopulated islands, such as Java, to areas still forested, such as Borneo and western New Guinea. These new immigrants are burning forests, with the encouragement of the Indonesian government, to create farms and grazing land for livestock. In the process, they are driving endangered species, such as the Orangutan, toward extinction. What should societies do in these circumstances, which will become more and more common in the future?

o Principle number 6 states that causing pain or distress in animals for our amusement is reprehensible and must not take place. Most examples of such cruelty involve domestic animals, such as steers in bull fights, roosters in

cockfights and pit bulls in dog fights. Consider situations in which threatened or wild animals are used in such ways. For example, Asian bears are abused in street shows, and Tigers and elephants suffer in circuses. Hunting rare animals for sport might be considered to fall into this category, especially when it is carried out by means that do not usually kill quickly, such as by bow and arrow, and when it is not done for food, but for amusement.

o Principle number 7 concerns causing unnecessary pain for experimental purposes. Such experiments often involve the use of threatened animals. Chimpanzees and monkeys are involved in painful experiments to test drugs, in simulated car crashes or other research. The use of these animals is justified by many research laboratories and others as being important because it can help human beings in various ways, such as finding cures to diseases. However, many experiments are unnecessary and repetitive of already published research. Does the treatment of these animals, especially long-lived chimpanzees who must spend a lifetime that can reach 60 or more years in sterile confinement, justify the research, or are there alternatives to using these animals? (Contact the Animal Welfare Institute for its published reports and articles on this subject.)

o Principle number 9 regards exploitation of animals for furs, skins and other luxury items. Many threatened species are legally traded for such purposes. All the wild cats that are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild of Fauna and Flora (CITES) may be traded with export permits, for example. The trade in elephant ivory during the 1980s nearly caused the extinction of both the African and Asian species. In 1989 all ivory trade was banned by CITES. Today, many countries want to reopen trade in African ivory, claiming they have stockpiles and overpopulation of elephants in some areas. Discuss the ethics of killing animals for luxury goods and select a species that is threatened with extinction as a result of such killing. This principle could also apply to the trade in live wild pets that threatens many species. Read the Trade chapter in this book for more information.

Books and Publications

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Film

"The Animal Contract," based on the book by Desmond Morris. Garner MacLennan London and Lifetime Pictures in association with Island Visual Arts and G.C. Films, UK.

Wildlife Music

Project Summary.

People once thought that animals were "dumb" because they could not speak in human language or that the seas were silent because we were unable to hear their sounds. Many still think that birds sing for people. We now know that wild animals communicate with one another and other species in thousands of different sounds. This project will acquaint students and others with many of these sounds. They have definite purposes and can communicate a wide variety of messages, whether territorial, warnings to members of their own species, mating calls or other meanings we have yet to understand. Human activities are having negative effects on the communications of some animals, even causing mortality. This project will encourage appreciation of the great variety of animal sounds, especially those of disappearing species. Means of preventing interference with animal communication and working to reduce human-created noise will be explored.

Background

A chorus of bugles as flocks of Sandhill Cranes take flight, the eerie violin-like songs of Humpback Whales or the croaking of frogs can evoke emotion and deep appreciation. Human response to wildlife songs reflects the universality of music. Virtually all human societies have their own music (see Milius 2001). Just as we are drawn to the sounds of nature, animals have been attracted to human music. The now-extinct Laughing Owl of New Zealand would fly close to a person playing an accordion after dusk, remaining in the vicinity until the music stopped (see Fuller 2001). Researchers in the Pacific Northwest have dangled microphones playing music from their boats and found that dolphins and Killer Whales approached and listened for long periods. The mournful, musical howls of wolves caused fear in the superstitious medieval times, but today they are appreciated as true animal songs, each wolf contributing a slightly different melody. In fact, when a recording of wolf howls was released during the 1970s, the music critic of *The New York Times* judged the musical talent of each wolf singer. (Wolf Education and Research Center: www.wolfcenter.org provides information on howling.) Songs play an integral role in wildlife communication and survival. Endangered denizens of American grasslands, prairie dogs, also have complex languages, giving different calls to one another to warn of birds of prey, land predators, humans with guns and other threats. Some bird songs, like those of many birds of paradise, stunningly beautiful birds of New Guinea, are so loud and bizarre that they seem to have been electronically produced. They are designed to penetrate dense foliage for long distances. Bellbirds and howler monkeys of Latin America and gibbons of Asia also sing so loudly that the songs carry for miles in the rainforests. Gibbons mate for life and sing duets in whoops that echo through the forest. Many wildlife songs are used to defend territories or to find a mate. Beluga whales and Mountain Lions communicate with one another in bird-like chirps. Elephants are now known to emit deep sounds, inaudible to humans, which carry for great distances to elephant herds miles away (see Payne 1998). Likewise, bats and dolphins emit ultrasonic sounds to find their prey and to navigate. Some of these are audible to the human ear. Many of these species are now listed as Threatened, however (see Endangered and Threatened Species list in the Appendix).

As the world becomes filled with human-made noise, from the giant engines of ships, planes, trucks and earth-moving machines to jet skis, snowmobiles, snow blowers and chainsaws, wildlife songs and calls are being drowned out. Each Humpback Whale has its own individual song. The males vary the songs each year, and females seem to be attracted to the males who emit the most complex songs. Marine mammals emit a great variety of squeaks, hums, squeals and chirps to communicate with one another and echo-locate, but they can be drowned out by ships, motorboats, jet skis and other human-made sounds. It is critical for the survival of these marine mammals that they be able to communicate.

Some ship noises are even lethal to marine mammals. The US Navy has been testing an anti-submarine sonar called Low Frequency Active Sonar (LFAS). Powerful sonar waves are broadcast underwater to test a means of detecting quiet enemy submarines (see White 2000a). These sonar waves can travel hundreds of miles and be extremely loud. Humpback Whale males have stopped singing or moved away when these waves were broadcast. More ominously, testing in 1995 off the coast of Greece coincided with an unusual stranding of Cuvier's Beaked Whales, resulting in the deaths of these seldom-seen whales. In March 2000, Ken Balcomb, a biologist familiar with sonar, was present in the Bahamas when a stranding occurred at the same time Navy LFAS tests were taking place nearby. Fifteen whales stranded, including Dense Beaked Whales, a Minke Whale and a Spotted Dolphin. All washed up on the shores, and when pushed back into deep water, they were unable to remain upright, clearly unbalanced, disoriented and apparently in pain. Without their hearing, they cannot find their way in the ocean. Nine died. Along with Harvard biologist Darlene Ketton, Ken Balcomb performed necropsies on several whales, finding their ears full of blood. In one case, hemorrhages striped the lungs. Further testing revealed that a whale had suffered a concussion, apparently the result of acute trauma from pressure (White 2000a). A press conference organized by the Animal Welfare Institute following these findings featured Ken Balcomb of the Center for Whale Research and other whale experts, who attested to the fact that LFAS is reckless, unnecessary and lethal to whales. Soon after, the Navy canceled testing of active sonar off New Jersey and also its scheduled tests on Sperm Whales in the Azores (White 2000a). The Navy has not cancelled these tests altogether, however, claiming that more research by Woods Hole Oceanographic Institute is needed to reach a final conclusion.

Bird reproduction has also been affected by the sounds of highway or airplane traffic. Researchers have found that male birds living near such loud noises cannot hear their own songs or those of their rivals and, in a few generations, begin singing songs so different from their instinctive ones that other males do not respond, nor do females, preventing reproduction. Frogs living near highways have also been found to lose their natural calls in the din of traffic noise. It is not known whether these animals have suffered hearing damage or are simply unable to hear fellow creatures over the din. Much of the noise created by human machines could be reduced or eliminated with muffling devices. Design of machines that will not interfere with animal communication should become a priority.

Activities

o Listen to recordings, such as fiMusic of the Birds,**fl** listed below. Visit websites that play animal sounds and songs. One, intended for visually-impaired people, plays bird songs: www.nhest.org; and www.naturesongs.com has many types of natural music. The largest collection of natural sounds in the world is at the Macaulay Library of Natural Sounds at the Cornell Laboratory of Ornithology (www.birds.cornell.edu). It has 150,000 recordings. The British Library's national sound archive has more than 130,000 recordings: www.bl.uk/collections/sound-archive/wild.html). The Nature Sounds Society website (www.naturesounds.org) gives information on other sites. For an academic approach, consult the site of the World Forum for Acoustic Ecology: interact.uoregon.edu/MediaLit/wfae/home/. Watch wildlife films that include songs and calls, especially those of threatened and endangered species, such as birds of paradise, whales, wolves and elephants (see list below and Video section). Write an essay on the songs of one group of species, such as whales, or a particular species, describing the variety of the songs or calls.

o Compare the wildlife sounds heard in environments far from highways and airports with those near them. Take walks in several types of habitats with experts who can identify wildlife sounds, such as frog chirps and croaks, bird songs and insect noises. Tape record the sounds heard and count the number of species in a quiet habitat versus those heard near a busy highway or airplane flight path. Note that each species' song can be heard in normal conditions

because of its own frequency and rhythm. Discuss the effect of noise on these species, and describe the various calls heard without interference.

o Learn about means of lessening human-created noise. Write the Environmental Protection Agency (EPA) in Washington, DC (see Organizations list, Teachers™ Aids section) for information on noise pollution and how existing engines can be muffled for quieter substitutes. For example, electric-powered lawn mowers and leaf blowers make far less noise than gas-powered ones. Airplane engines that are quieter than those currently in use have been designed, but no strong government mandate has encouraged their manufacture. Automobile and truck engines can be made quieter, and certain road surfaces can decrease traffic sounds. Snowmobiles that emit far less noise have been manufactured, but without legislation mandating their use, there is little demand. Consult the Internet for organizations working actively to require that quieter machines be in use. Write a report on the need for noise pollution equipment.

o Research the effects of snowmobiles, jet skis and all-terrain vehicles on wildlife. Contacting various organizations, including the National Parks and Conservation Association (see Organizations list in Teachers™ Aids section) for information on their work to keep these vehicles out of the national parks because of the negative effects the noise has on wildlife. Find out the decibel levels of various vehicles that are allowed in wildlife areas and off-road wilderness parks and their effects on various species of wildlife.

o The US Navy testing of anti-submarine sonar, Low Frequency Active Sonar (LFAS), described above, has been shown to be extremely dangerous to some marine mammals and drives others away from their traditional migration and feeding areas. Write the Animal Welfare Institute for more information on this program and how to help stop it.

Books and Publications

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Films

The following represent only a few of the many films concerning animal calls and music. See the Video section of this book for further listings. Also, many audiocassettes are available with wildlife sounds of various types.

"Attenborough in Paradise." 1 hour. Nature (PBS). BBC. 1996.
David Attenborough visits New Guinea and describes the birds of paradise and their extraordinary calls.

"Crane River." 1 hour. National Audubon Society. PBS Video. 1988.
Hundreds of thousands of Sandhill Cranes migrate in the Midwest, bugling, calling and courtship displays, which resemble minuets.

"Gentle Giants of the Pacific: Humpback Whales" 1 hour. Sierra Club Series.
Wood Knapp Video. The amazing songs of these whales are heard in this film.

"In the Company of Whales" 90 minutes. Discovery Channel. (VHS & CD•ROM.)
1992. Following great whales and hearing their sounds with zoologist Roger Payne and other experts, insights are given on whale behavior and biology.

"Jaguar. Year of the Cat." 1 hour. Nature (PBS). Telenova Productions. 1995.
Filmed in the rainforests of Belize, the daily life of Jaguars is seen in remarkable close-ups accompanied by the sounds these cats make as they walk in the forest or lap water in a stream, with insect and bird songs in the background.

"National Audubon Society's Video Guides to North American Birds." Five one-hour cassettes. National Audubon Society. These videos show and record all species in the United States and Canada for which photo documentation exists. Audiocassettes of almost all the native breeding birds are available from this organization.

"Wild Wolves." 1 hour. BBC. NOVA. PBS. 1997. This film examines the true nature of wolves, their behavior and ecology and lets us listen to their howling.

Catalog of books and CDs with audio samples: www.earthear.com

Lawns

Project Summary

Many biologists and conservationists are now questioning the use of green lawns in yards, in front of public buildings and along highways. In general, green lawns have to be maintained through use of chemicals that can pollute the groundwater and kill beneficial plants and insects; use noisy, gas-guzzling mowers and leaf-blowers; and fail to preserve native plants. This project involves examination of the effects of these lawns on the environment and human health, as well as the use of energy and water to maintain them.

Background

Most biologists consider grass lawns to be ecological deserts because of their lack of diversity. In many areas, grass lawns cover a large percentage of land in villages and suburbs. Golf courses are increasing in number. Lawns are replacing natural habitats, such as woodlands, grasslands, shrub and desert and, in the process, wildlife and natural landscapes retreat. The Eastern Box Turtle has lost a large percentage of its original long grass, shrubby habitat to green lawns, and the species has declined dramatically. These slow-moving reptiles are also badly injured or killed by lawn mowers, which smash their shells (see Stevens 1994). Migratory birds and butterflies return in the spring to find

their natural habitats converted to green lawns, depriving them of feeding and breeding sites. In general, lawns provide little or no habitat for wildlife.

To keep them green, herbicides, pesticides and chemical fertilizers are sprayed or spread in vast quantities. More than 67 million pounds of chemicals are placed on US lawns annually (see Wasowski 2001). These chemicals kill useful native animals, such as pollinating insects, birds that disperse seeds and consume insects, burrowing rodents, and earthworms that aerate the soil. They also contaminate the groundwater. Some of these poisons are so powerful that they have caused sickness and death in humans. Early in 2001, the city of Halifax, Nova Scotia, Canada, became the first in North America to order a ban on all insecticides, herbicides and fungicides used on lawns. The ban was primarily intended to protect human health, especially children who are most vulnerable to pesticides (see Nickerson 2001). Fifty-five other communities across Canada are considering similar bans. Opposition to grass lawns and frequent mowing along public highways is also growing. One citizen of Orleans, Massachusetts, objected to the *The Boston Globe* when mowers destroyed carefully planted native wildflowers growing along a major highway in this Cape Cod area. The flowers, planted by volunteers (one as old as 85), of the New England Wild Flower Society, had been clearly posted not to be mowed.

Green lawns require constant care and use enormous amounts of energy for mowing, edging and removing leaves. Most lawn mowers and leaf blowers consume gasoline and pollute the air with fumes, while also creating noise pollution. Mowers also damage tree trunks or kill above-ground tree roots, especially of old trees, and frequently-applied fertilizer can harm older trees, which need slow-release enrichment of the soil (see Stocker 2001). For these reasons, gardeners recommend that no large tree be within 2 feet of a lawn. Another threat to trees is lawn watering during droughts; an insufficient amount of water reaches the tree roots, while the lawn absorbs most of the water (see Stocker 2001).

Lawns are also extremely costly. The American Nursery and Landscape Association estimated that Americans spent $17.4 billion on their lawns in 1999 (see Schembari 2001). The Lawn Institute, based in Illinois, estimates that the lawn care industry for North America is worth more than $25 billion (see Nickerson 2001). By planting perennial native grasses, shrubs, trees and flowers, homeowners could save literally billions of dollars.

The grass used for lawns in the United States is composed of various European turf species, which, unlike most native American grasses, require large amounts of water, often as much as a third of local water supplies. Householders use 40 to 60 percent of their water on their lawns in the summer. Erroneously called "Kentucky Blue Grass," this and other commercially distributed grass seed needs cool, damp climates for healthy growth. The grass quickly turns brown in the heat of summer or when not watered enough. In dry seasons, many towns mandate water rationing because lawn watering has depleted local supplies. The average lawn will use up to 10,000 gallons of water of a summer and 10 times the amount of pesticides as an acre of farmland (see Egan 2001).

Communities being built in dry areas, such as southwestern deserts, tend to plant green lawns because their owners have come from areas where they were typically used. In desert areas, green lawns can only be maintained through diversion of water that dries up rivers or alters the ecology of these regions. In Arizona, for example, several rivers have been reduced to dry beds by diversion for the burgeoning developments surrounding Phoenix and Tucson. Cities of the Southwest and California use enormous amounts of their water supplies to water green lawns. In the process, several pairs of endangered Bald Eagles that nested on one of these rivers, along with thousands of other forms of life, disappeared. One new resident of Phoenix, an architect, planted native plants in his garden instead of grass, defying local developers**,** who remove all native vegetation and cover the land with gravel. His yard was soon filled with wild marigolds, creosote bushes and other plants that seeded themselves in his beautiful, no-maintenance back yard. In Glendale, Arizona, homeowners receive a $100 rebate for converting 50 percent or more of their grass to shrubs or plants. Studies from Las Vegas found that a city could save 40 percent of its water by converting to non-grass alternatives. With the world facing increasing water shortages, the grass lawn, especially of non-native species of grasses, has become a luxury that is wasting this precious resource.

Green lawns can be grown with native grasses that do not require artificial watering and chemicals, and by using the cut grass as mulch. Fertilizers and herbicides are not necessary for these lawns, which can be mowed with electric or old-fashioned, human-powered mowers. Also, smaller areas can be planted. Instead of dominating the yard, lawns can become a minor part. Planting native vegetation, including wildflowers, shrubs and trees, in back yards and city lots is a preferable alternative to the green lawn. In shady, moist areas, mosses can be planted that never require mowing and stay green year-round (see reference list below). Perennial plants do not need replanting each year and require almost no maintenance. Trees provide shade, erosion control and habitat for wildlife. Planting a garden with native American plants can also aid in the conservation of ecosystems and rare species. By not using chemicals, groundwater and wildlife are protected.

Activities

Consult the books listed below before beginning the following project:

o Select two small land plots (each about 200 square feet) each distanced from one another by at least 100 feet. Prior to planting, take samples of soil and examine them under a microscope to determine the diversity of plants and animals, whether there are earthworms to aerate the soil, and other life forms. Measure the acidity. Describe the soil's texture, whether rich loam, clay or sand, and whether it is dry and crumbly or moist. Are there birds that feed in the grass or evidence of small mammals, such as tunnels? In one half of the plot, plant non-native grass and use the chemicals recommended by the grass seed company. Water and mow the lawn, if needed. On the other half of the lawn, dig up the soil and spread natural compost from leaves and other vegetation throughout, to a level of 2 feet. Sow seeds of native grasses**,** such as buffalograss (sold in many nurseries). Water this portion until the seeds are established, but not afterward. Do not apply any artificial fertilizers or other chemicals. Mow with electric or hand mower only. After one month, take soil samples from both areas and examine them under a microscope to determine the diversity of microbes and the moisture content in the two soil samples. Note whether the organic wildlife area has above-ground evidence of wildlife such as butterflies, small mammals, reptiles, amphibians and birds. Identify them by species. Did the organic grass survive without artificial watering? Compare the two soils, their moisture content, invertebrate species diversity, water usage, environmental effects and the cost to maintain each one. A third alternative is described in the next project, fiLiving with Nature,fl focusing on conversion of the lawn to native wildflowers, bushes and trees, which requires even less water and labor.

o As a study project, select a suburban area of approximately one city block and measure the acreage in green lawns, calculating the cost in use of chemicals, as well as gasoline for lawn mowers and leaf blowers. Estimate water consumption and the percentage of this that must be artificially applied through hosing or sprinklers. What is the water source? Ask the local water department how much water is used in your area for watering lawns each year. Contact the Environmental Protection Agency in Washington, DC, for information on contamination of groundwater by lawn chemicals and their effects on wildlife and human health.

Books and Publications

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Living with Nature

Project Summary

This project focuses on planting a garden with native plants and creating natural habitats that will attract wildlife and provide breeding and feeding areas for a wide variety of species. If an area for planting is not available, the principles of a natural garden can be learned. Also, the project discusses means of avoiding any lethal methods to control insects or animals with which one can come into contact in one's home or back yard, including Raccoons in garbage pails, deer munching shrubbery or moles burrowing in garden plots.

Background

The ecological problems presented by green lawns (see previous project) have brought many people to realize that many gardens and yards tend to reflect a lack of ecological knowledge and concern, and fail to preserve a natural environment and maintain wildlife habitat. This subject has resulted in many books and even garden magazine articles, but only a small minority of homeowners have abandoned the green lawn or reduced its size, making it a small part of one's yard rather than the dominant component. The long-term goal of converting lawns to natural environments is to provide wildlife with habitat it has lost in recent times, a period during which housing developments gobbled up millions of acres of woodland and pastures. Also, lack of tolerance for wildlife has increased, with homeowners moving into areas only recently converted to housing to be dismayed and often fearful when they find wildlife in the back yard. These animals were the original tenants of the land, and we are the invaders, but few homeowners seem to realize this fact and want nature to be tamed and non-invasive. Common sense approaches to this potential conflicts will be explored.

Activities

o Conversion of a yard from grass to natural vegetation can be done at once by digging up the entire lawn, excavating at least 2 feet to aerate and compost the soil, and replanting. A natural garden can also be planted gradually, plot by plot. The most important step is preparing the soil by enriching it with natural compost and organic fertilizers so that soil microorganisms and invertebrates, such as earthworms, can flourish and plants will have a better likelihood of surviving. Acidity testing is important to create a soil condition to which the type of plants used will adjust. Conifers, mountain laurel, rhododendron and related plants require high acidity, while grasslands and meadows tend to be more alkaline. Use no pesticides or artificial chemicals. Also to be avoided are bug zappers. These electric units that hang outside and electrocute insects have been shown to kill thousands of useful insects, such as moths, but almost no mosquitoes, for which they are intended (see *Wildlife Conservation* magazine, July/August 1997). A school class can utilize a plot of land of varying size according to the amount of time and effort it can expend. Many of the books listed below provide clear guidelines to follow in establishing a garden with native plants. Plan the garden to conform to the regional ecosystems, and use only plants native to the area. Some of the suggestions made in various books and articles include planting non-native plants to attract butterflies or birds. This should be avoided, and such plants should be removed. Consult guides to native plants to determine whether a species is indigenous. The best sources for native plants are organizations, such as the New England Wild Flower Society in Framingham, Massachusetts, that propagate all plants sold and recommend that no wild plants be dug up from woodlands or other natural habitats. The

most coveted and delicate species, such as damp woodland trilliums and lady slippers, will almost surely die if transplanted from the wild, as they live in a symbiosis with fungi. Moreover, they require many years to mature and are rare in the wild. The habitat established--whether a woodland, small pond with water plants, prairie with wildflowers, desert landscape with cacti or marsh--should be compatible with local vegetation. It might consist of recreating a habitat destroyed by developers on the very site. If the lot is completely open without shade trees or even bushes, it is not possible to establish a woodland environment immediately. The planting will have to be transitional, using species that would naturally seed in such areas, such as birch and ground cover plants in northern and mountainous areas. Whichever habitat is chosen, carefully record which plants are introduced and their survival on a regular basis.

o If you are creating a butterfly garden, follow instructions such as provided in the booklet, "Butterfly Gardening in New England," to establish shrub plants for the larvae, fragrant flowers to provide nectar for adults, a damp area for moisture and mineral feeding, and tangles of vegetation for the caterpillars. Keep in mind the locality. Host plants differ in each region of the country. In an open environment, a field of native goldenrod, milkweed and a diverse selection of plants would have the best likelihood of survival and attract butterflies of many species. Many butterflies specialize in a particular type of host plants, and only these can be planted. Flowers that attract many species of butterflies are a good introduction to such a project. When the flowers have appeared, spend an hour each sunny afternoon recording the species and numbers of butterflies that come to feed. Later in the season, try to find eggs, chrysalids and caterpillars among the vegetation. A good source for more information on this subject is *A World for Butterflies*. Photograph them. Note also other types of wildlife that come, whether birds, small rodents or other species. Write a report on the project, recording the successes and failures from beginning to end. The flowers may be left indefinitely, as they are perennials.

o Animals such as Raccoons, squirrels, deer, skunk, moles and rabbits are often seen as pests to be eliminated if they cause damage, eat prize plants or vegetables, or create burrows in the soil. What seems to be a major problem that can only result in trying to eliminate the animals can be solved or attitudes changed so that wildlife is better tolerated. *Living With Wildlife*, a book published by the Sierra Club, is based on the experiences of the California Center for Wildlife, a wildlife rehabilitation and education center with more than 200 volunteers and a professional staff. They receive more than 12,000 calls a year from people who have problems dealing with animal nuisances. Many problems, such as animals eating garden vegetables, can be solved with fencing, having garbage cans that cannot be opened by animals or are placed behind barriers, and spraying bushes and vegetation with substances and odors that repel animals. For example, to "raccoon-proof" a garbage can, fasten the lid securely with rope, bungee cords, chain or even weights. Secure the handle to a metal or wooden stake driven into the ground to prevent it from being rolled around. Store cans in wooden bins or in a locked shed or garage. Certain smells, such as ammonia, repel animals and can be sprayed on bushes or garbage cans. This book gives specific advice as well as encouraging a tolerant and positive attitude toward wildlife, reflecting the knowledge that we have entered *their* territory, not the opposite. If one's home has destroyed important habitat for wildlife, it is important to consider recreating it by allowing brush and shrubs to grow, instead of neat flower beds, to provide habitat for turtles, rabbits and groundhogs to share the property. Consider that a graceful deer in one's yard is a privilege to see. To protect special trees or fruit, spray them with repellants that contain milk, and hang bags of human hair. Most people choose to share their yards with deer and other wildlife, planting vegetation for them. It is also important to be tolerant of predators, such as bear, Cougar, Coyote and wolves, while staying far away from them. These predators, especially Cougar and Wolves, play an important role in regulating populations and maintaining the strength of deer and other ungulates. The overpopulation of deer in many parts of the country can be blamed on direct persecution of large predators. These predators should never be fed or approached, however, but allowed to exist as vital components in ecosystems. Few people are aware that Coyotes and foxes are important consumers of mice. A key factor in developing tolerance of wildlife is to understand their need to survive and to learn about and respect their natural behavior.

Books and Publications

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Lifestyles and Citizen Action

Through small changes in our lifestyle, we can reduce our use of energy, our pollution, our unnecessary consumption of material goods and help wildlife and the natural world. By launching programs within our community and making other contributions to conservation, we can have an even greater impact. This project will examine some examples of each conservation approach and encourage activism to preserve nature and endangered species. It will make recommendations about purchases that can either aid or damage the environment and wildlife.

Activism on the part of individuals and governments is crucial to reversing the trends that are extinguishing species and habitats at an unprecedented rate. The natural world is a place of beauty that provides a cornucopia of medicines, food and inspiration. The majority of scientific discoveries lie in the future. Preserving these treasures should be the most important goal of society. Future generations will not forgive us if we extinguish this precious heritage, upon which we depend for our very lives.

The majority of people on Earth are too occupied with survival to understand and act on the need to preserve species and natural environments, especially wilderness areas. Those people who can teach means of sustainable living without harming nature should become far more active to prevent further extinctions and erosions of natural ecosystems. On the whole, we have failed to treat the environment and our fellow creatures with the respect needed to prevent further losses to our natural heritage. Never before, however, have we known so much about the components and functioning of ecosystems, nor have we had the technology and the will with which to remedy past errors in order to live in harmony with the Earth.

<u>Land Protection</u>

Sustainable Living
Internet Solutions
Purchasing Power

Lifestyles and Citizen Action: Land Protection

Background

One can contribute to the preservation of biological diversity worldwide in many ways. Land protection is key to species' preservation. In foreign countries, biological diversity is at great risk, with extinctions occurring on a daily basis. Through support of international organizations, vital tracts of land can be purchased or the government convinced to designate them as national parks. In the United States, bogs, vernal ponds and other temporary wetlands, longleaf pine forests, old-growth cedar forests, tallgrass prairies and desert springs are some examples. They are vital to the survival of countless species, but receive little or no state or federal protection from destruction, and harbor many endangered species. Making a project of protecting a threatened habitat and/or species could spell the difference between survival and extinction for a particular plant or animal species, a very worthwhile project.

Activities

o Support organizations that specialize in setting aside land. This is key to saving the wildest, most pristine and important habitats before they are ruined. By obtaining issues of past magazines and press releases of organizations, such as The Nature Conservancy or Conservation International, learn what land they have protected that provided important habitat for endangered species and how they work to identify and protect biologically important areas in need of conservation. Help an organization that is raising money for land that harbors rare or endangered species in a foreign country. One class raised more than $100,000 to purchase a sizeable rainforest tract, teeming with beautiful tropical birds, in Costa Rica. Far less funds per acre are needed to acquire land in many countries where biodiversity is high than in the United States or Europe.

o On a local basis, a class could save an endangered species by helping to purchase its habitat. Information on a state-by-state basis on endangered species and habitats can be obtained from the Natural Heritage Programs connected with each Environment or Wildlife Department. These programs identify rare, endemic and declining species and their habitats, including those in need of protection. Also, national, state and local organizations and government departments can help in identifying land in need of protection. In some cases, an organization that specializes in a particular type of animal, such as frogs, cranes or turtles, will know of such areas and may already be raising money to purchase them. The class can choose an area in need of fund-raising and begin to aid in a fund-raising campaign. It would be more feasible to choose land that is not so expensive or large that many years would be needed to purchase it. The Nature Conservancy or another organization may be preserving the land. Another option is to launch a campaign to convince a town, state or federal agency to designate an area as protected. A field trip should be taken to the site, guided by a biologist familiar with the habitat--its plants and animals. Someone in the class could be designated to photograph the site, while others would take notes on what the guide says for a report and write letters to the editors of local newspapers. The site may preserve one or more endangered species, as well as an endangered habitat. Once successful, contact local newspapers to publicize the event, and write up the achievement in terms of how the goal was attained and what biological treasures were protected.

Lifestyles and Citizen Action: Sustainable Living

Background

A growing number of organizations are providing people around the world with alternatives to destroying forests and other natural habitats to clear land, obtain firewood or raise livestock. In tropical areas, land cleared of rainforest can be farmed for only a few years because of poor soil. Organizations are now helping these farmers survive in ecologically friendly ways through donation of solar cookers and heaters, aid in establishing small farms that utilize bio-gas (methane obtained from manure and sewage), and promotion of self-sustaining farming methods that do not destroy the environment. In Madagascar, primatologist Patricia Wright protected the forest home of endangered lemurs by convincing the government to establish a large national park. It provided many jobs for local people. She then raised money for the construction of schools and clinics. Deforestation has virtually stopped as a result, and the people have become protective of the forest after learning how it prevented mudslides. Providing this type of help for people in poor areas of the world will be a major project of Conservation International, which plans to integrate this approach with its land protection and biodiversity studies, through a donation it received of more than $1 billion.

Activities

o Select one or more threatened habitats that are being destroyed as a result of over-grazing, deforestation or other means by people in developing countries. Many examples are given in the main text of this book. In classroom discussion, explore the ways in which these areas are being destroyed. What habitats and threatened species are disappearing as a result? What do you think should be done to prevent this situation from continuing and to help the people at the same time? For example, in Central Asia, so many sheep, yak, horses and other livestock are grazed by nomadic people that they are ruining the grasslands, leaving little food or habitat for native gazelles, wild camels, antelope and wild horses. Native predators, such as wolves, bears and Snow Leopards, are killed as potential threats to the livestock. Make specific suggestions that would provide for the basic needs of the people by alterations in their lifestyle and simple technology, while preserving the ecosystem.

o Consult the Internet and other sources for organizations that distribute solar cookers and simple technology, as well as agricultural advice. Contact them with suggestions for areas to donate that harbor many endangered species and habitats. Ask which countries are the recipients of this aid. Find out which parts of the world are not receiving international aid and, if these areas are environmentally threatened, suggest that they receive aid.

Lifestyles and Citizen Action: Internet Solutions

Background

Internet websites provide a new avenue to protect the planet through programs like "click-to-donate." Merely by clicking onto the Internet site, one activates funding for wilderness, endangered species and environmental protection from corporate pledges. EcologyFund (www.ecologyfund.com) is one such website that receives more than 100,000 visitors each month. In exchange for ad exposure, the fund donates sponsors' money to protect wilderness, plant trees and reduce pollution. Threatened wilderness land in the United States, Canada, Mexico, Africa, the Amazon Basin, Patagonia and Scotland has been preserved, and the fund claims to protect 187 square feet of land and save 2 pounds of carbon dioxide per visitor every day. Care2 (www.care2.com) also has a "click-to-donate" program focusing on endangered species and rainforest protection. One of its programs, "Race for Big Cats," has protected 16,000 square miles of key habitat for endangered Tigers, Jaguars and Snow Leopards, in conjunction with the Wildlife Conservation Society. In cooperation with the Nature Conservancy, Care2 has purchased large tracts of rainforest.

A related approach to preserving wildlife and funding conservation work consists of Internet sites that tune into live videocameras located in national parks or other natural areas, sending signals to satellites. Some websites are free, while others charge a small fee. Cameras set up in South African national parks (www.africam.com) focus on wild animal lairs, waterholes and other wildlife spots. They have generated large sums of needed money for the park

system. In the United States, television cameras have been trained on Peregrine Falcon and Bald Eagle nests and transmitted to a cable station that plays the picture. Solar-powered videocameras have been designed that can be placed in the most remote wilderness with no need for batteries or outside electric power sources. This concept has great educational potential, simultaneously raising money for endangered species and wilderness protection, while educating as well. Such websites can provide important information on these subjects while providing exciting views of wildlife and wild places. As an alternative to eco-travel for those of lesser means or those unable to travel, such websites could offer tours, such as tree-top views of rainforests and their abundant wildlife, or close-ups of seabird colonies or coral reefs. They have the added benefit of protecting delicate ecological areas from the effects of too many tourists. Such websites should provide a portion of the funds to local people as an incentive to preserve the land and wildlife. If significant funds were generated, countries faced with choices such as whether to allow corporate logging, commercialization of wildlife, dams and other projects needed to repay national debts, might consider these cameras to be a better alternative. If successful, such websites would encourage countries to maintain large areas of wilderness. Videocameras also have a scientific potential in giving a 24-hour view of areas harboring wildlife, often difficult to observe through other means.

Activities

o Click onto several videocamera sites to see the various types of wildlife spectacles offered. Some examples: seemorebears.com (Alaskan bears feeding on salmon in season); www.african.com (see above); www.world-stream.com (views of ancient species of fish, the Coelacanth); zooatlanta.org (Giant Pandas). What threatened species or habitat would you like to see on a videocamera placed in the wild? Would you also like the views to be part of a menu offering information on the species and the habitat? What ideas do you have about the applications and potentials of these live videocams linked to the Internet and television cameras broadcasting to cable television stations?

o Select a country that is suffering high levels of environmental destruction
but also has beautiful scenery and many endangered species. Discuss the potential of proposing alternatives to such a country, i.e. placing videocameras as income producers versus commercial logging, a short-term destruction versus a long-term investment. What scenery and wildlife would you think would attract Internet users in this country?

Lifestyles and Citizen Action: Purchasing Power

Background

Developed countries consume 80 percent of the world's natural resources. If not for consumers in these countries, no market would exist for many luxury products, such as mahogany, teak and rosewood. The deforestation taking place to harvest these woods pushes many species of animals closer to extinction. Loggers take the largest and oldest trees. These are the ones most valuable as wildlife habitat, oxygen producers, carbon dioxide absorbers, soil stabilizers and water retainers. In spite of some programs meant to encourage "green" forestry practices, even selective logging, in which only a few trees are taken per acre, all types of logging have negative effects on pristine old-growth forests and their wildlife. (See Forests chapter). Many species are directly endangered through loss of habitat and hunting. People enter previously impassable forest on logging roads to kill Gorillas, chimpanzees, elephants, rare antelopes, birds and other wildlife for bushmeat markets and animal products for Traditional Medicine. (See Forests chapter). Old-growth forests in some parts of the world have been growing undisturbed, harboring the same types of trees for hundreds of millions of years. These forests are irreplaceable repositories of biodiversity and living pharmacies, precious for their scientific value as extraordinarily rich ecosystems. Scientific knowledge of the functioning of these forests and an inventory of their species has only just begun. Cutting one tree can kill a dozen that come crashing down as jungle vines entwine whole groups of trees and branches that stretch for long distances knock down neighboring trees. In the process, many animals lose their lives and habitats. Nest holes for birds, mammals, reptiles and insects, loose bark under which forest bats roost, tall canopies for eagles' nests--all are lost. The logs obtained are

not essential for human survival, but are sold as raw material for coffee tables, wall paneling and lawn furniture for the wealthy. Thousands are cut merely to manufacture shipping cartons or chopsticks, used once and discarded. more than 80 percent of these old-growth rainforests have been logged in the last century, greatly reducing the production of oxygen, water vapor and absorption of carbon dioxide. Certain products, such as Brazil and cashew nuts, can be extracted from tropical forests without harm. Ecotourism has great potential as a means of income. If profits are shared with the people who gather them, they will have an incentive to protect these trees. Other products that damage forests, especially tropical forests, are wooden carved boxes and tourist knick-knacks made from scarce woodlands in India, Indonesia and other countries where forests have been decimated.

Coffee was once grown in the shade of tall forest trees, but with the development of new strains of coffee plants, forests are being cleared to grow coffee in the sun (see the Forests chapter). Coffee grown in the shade is far more ecologically-friendly, since large trees are preserved. Many North American birds migrate to the tropics and winter in coffee plantations. The sun-grown coffee has deprived wildlife of this habitat. A campaign to return to shade-grown coffee, especially if grown without pesticides, was launched by the Smithsonian Institution a few years ago. Some commercial importers have provided a market for this shade-grown coffee, enlisting coffee farmers in many parts of the world to protect forests and grow coffee as an understory. Now this coffee is available in many US stores, marketed as "Shade-grown," "Bird-friendly" or "Shade-grown--Organic." Many of these coffees are comparable in price to, or only slightly higher than, sun-grown commercial coffee grown using pesticides. They have the added advantage of being healthier, since they contain no dangerous chemicals. Likewise, most bananas are grown with massive amounts of pesticides and herbicides, but many growers are now producing bananas organically. Ask your local grocery store to stock them and be aware that purchasing them helps the environment. A similar problem exists with the growing of chocolate from the cacao plant in tropical areas. Its great popularity in the United States has encouraged the clearance of forests for large-scale plantations that grow the plants in the sun, using fertilizer, fungicides and pesticides (see Khamsi 2001). Diseases have broken out in the large plantations, requiring heavy use of pesticides, fungicides and other chemicals to control them. Organic Commodity Products (OCP), a supplier in Cambridge, Massachusetts, promotes the growing of cacao in shade without artificial chemicals. Fortunately, 85 percent of the world's cacao is shade-grown. Some 6million small farmers who cannot afford pesticides provide this crop. Several chocolate companies are now marketing organic chocolate to promote environmentally friendly agriculture (see Khamsi 2001).

Caviar from sturgeon native to Russia and the Caspian Sea is one of the most valuable wildlife products. Sales in the United States and other importing countries have pushed virtually all Eurasian sturgeon species close to extinction. Even famous French chefs, including Jacques Pepin, recommend a boycott of Beluga, the most valuable caviar, which comes from the most endangered sturgeon species. Many other fisheries products come from species that have declined 90 percent or more in the past decade from overfishing. Atlantic Cod, Orange Roughy, Chilean Bass, Atlantic Bluefin Tuna, sharks of many species and swordfish have been seriously overfished. Many of these fish, such as sharks, are slow-reproducing, not having young until they are as old as 20 years. It is likely that their populations will never be able to sustain a commercial take. Pollack is a white fish from Alaskan waters that is being overfished to manufacture artificial crabmeat. The pollack fishery endangers Steller's Sea Lions, depriving them of a major food source. Shrimp from the Gulf of Mexico and many other tropical areas endanger sea turtles, which drown by the thousands in shrimp nets, which also catch millions of tons of unwanted fish that are discarded. Some shrimp is caught using nets that allow sea turtles and other non-target species to escape the net through turtle excluders, and these shrimp are often labeled "turtle-safe." Farmed shrimp and salmon involve environmental destruction. Mangroves are being cut in tropical countries around the world to construct shrimp farms, which emit large amounts of pollution. Farmed salmon are kept in off-shore pens, but many escape to breed with wild salmon, endangering the latter. The pens also contribute large amounts of pollution to the ocean.

Likewise, mining operations devastate entire ecosystems to obtain gold for jewelry and other minerals. The United States provides an enormous market for gold, the majority of which is made into jewelry. Even national parks in Indonesia are now permanently scarred, with large areas of land and rivers devegetated and poisoned with cyanide, which is used to separate the gold from ore. This country has the highest number of threatened species in the world, a

majority of which are found only here. Orangutans are being driven from their forest homes in Indonesian Borneo and Sumatra by loggers and gold miners, their populations now facing extinction in the wild. It is such activities that are fostered by the market for gold. Diamond extraction can destroy wildlife habitat and river bottoms, as well as causing human rights violations when used as currency by dictatorial governments who torture their citizens. Pearl cultivation damages American aquatic ecosystems. Pieces of mussel shell are inserted into living oysters, which causes the oyster to exude pearl material to surround the mussel shell. The mussel shells used for this cultivation come, for the most part, from the United States. Millions of tons of these shells are dug out of riverbeds, threatening some species.

As discussed in the Trade chapter and the previous project, millions of wild animals are captured for the pet trade and specialty collectors in wealthy countries. Parrots, cockatoos, macaws, turtles, tropical fish, snakes, lizards--and even frogs--are plucked from their tropical homes to be sold in pet stores. Some species have been driven to the edge of extinction by the wild pet trade, which also treats these animals inhumanely. The United States bans the import of most wild birds, but many species are still permitted under the Wild Bird Conservation Act. Also smuggling, a multi-billion dollar activity, funnels thousands of animals into pet stores where they are represented as legally taken or even captive-bred. Only 10 percent of shipments entering the United States are inspected for wildlife. For the majority of wild animals in the pet trade, little protection exists. Although the US Endangered Species Act and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) have helped limit trade, strict controls exist for only a small minority of the most endangered species. Since the United States is the world's largest wildlife importer, the effect on wildlife has been catastrophic.

Lizard, snake and crocodile handbags, shoes and luggage; ivory; feathers and other wildlife products are part of a trade that has endangered hundreds of species. Even if the product was not made from an animal on the US Endangered
Species List, it may be threatened by trade or inhumanely captured or killed. At present, for example, the reptile product trade is killing millions of snakes and lizards for leather products, causing many species to become threatened. Yet almost no controls have been placed on the trade, and what controls there are contain loopholes making them ineffective.

Many plants are endangered by harvesting for collectors. Rare cacti, delicate woodland and wetland species such as Venus Flytraps, Yellow Lady Slippers and other orchids, South African protea and a long list of other plants are being plundered in the wild. Many of these plants cannot be raised in captivity and have been illegally dug up in the wild.

Activities

o Write a report on the effects that American consumers have on old-growth tropical rainforests and their wildlife.

o Ask local stores if they carry shade-grown and organic coffees and, if not, would they stock them? Several grocery store chains and many health food stores sell these coffees. In restaurants and coffeehouses where coffee is served in large quantities, ask them to purchase at least a portion of their coffee as shade-grown, organic. Write the Smithsonian Institution's Ornithology Department for more information on the effect of sun-grown coffee on birds and other wildlife, and write a report on the subject.

o Select one of the jewelry materials mentioned, such as gold. Read the Forests chapter in this book and other references to the mining of gold in South America, Africa and Asia and its effect on the environment and wildlife. Write a short report on the mining operations in a particular country and their effects on wildlife and the environment. If purchasing jewelry, choose artificial diamonds, pearls and gold. These items can hardly be distinguished from the genuine ones because of advances in simulation technology. Other types of gem and metal mining also damage the environment.

o Discuss the general reasons for boycotting wild pets; fur coats; reptile products; feathers; caviar; threatened fish; turtle meat;, Traditional Medicine remedies made from wild animals, such as snakes, bear, seahorses and other

animals; other wildlife products and rare plants that you have seen in stores. Select one species (or group of species, such as sharks) and write a report on how the trade is threatening it and how to publicize the need to boycott its products.

Books and Publications

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Films

"Affluenza." America's materialism affects the world's environment, destroying forests and other environments. Solutions to the out-of-control consumerism are offered in "Escape from Affluenza."

"Cultivating Opportunity. Self-Help Solutions to Poverty in the U.S. and Africa" focuses on small-scale farmers forming cooperatives to protect themselves against corporations taking over their land.

"Mountains of Gold" tells the story of Brazil's gold rush and the thousands of prospectors who pan and dredge gold in the rainforest.

"Secrets of the Choco" explores the survival of the Choco tribe in Colombia and its rainforest, threatened by highways and non-sustainable development. Six world experts on tropical ecology and sustainable development discuss the region's future.

"Super-Companies" concerns the operations of multinational corporations in terms of raw materials and how they are affecting the needs of people and the global environment.

Projects

Profile of an Endangered Species

Project Summary

Select a species threatened with extinction from the lists of endangered species in the Appendix of *The Endangered Species Handbook*, the *2000 IUCN List of Threatened Species* or another list mentioned below. Using the list of numbered information below as a guide, list its common name, scientific name and other information in that order. Not all of the questions listed below can be answered from available sources, but give an overview with as much information as possible.

Background

Species threatened with extinction may be classified in categories such as Critical, Endangered, Threatened, Vulnerable or Imperiled on various lists such as the US Endangered Species Act, the International Union for the Conservation of Nature and Natural Resources' (IUCN) *2000 Red List of Threatened Species*, publications of The Nature Conservancy or other organizations listed in the Organizations list in the Appendix. (For definitions of the US Endangered Species Act and the IUCN categories, see the list of Endangered and Threatened Species of Mammals, Birds, Reptiles and Amphibians in the Appendix.) This project seeks to describe species in decline or those on the verge of extinction. The number of plants and animals in these categories has increased in the past few decades. Of the many causes threatening species, the disappearance of wild habitats is the most important overall. But for many species, rampant trade and introductions of non-native species are the primary causes. Pollution, pesticides and other toxic chemicals, thinning of the ozone layer and other environmental problems play roles as well. For some species, several of these factors contribute to their decline.

The attitudes of people toward the environment and wildlife in areas where these species are found are often of extreme importance in deciding whether habitats are conserved, laws passed to prevent killing and trade and other conservation measures taken. In some countries, such as Bhutan in the Himalayas, wildlife is held in high regard, and heavy penalties are exacted for destroying the natural landscape or killing animals. In others, high population pressures, faltering economies and political chaos result in destruction of forests and wildlife for commercial purposes, in spite of protective laws and many concerned citizens. In the United States, the US Endangered Species Act is supported by the majority of people, but opposed by a large segment, who see it as politically and economically intrusive. Thus, the conservation status of species threatened with extinction is a complicated picture.

Legal protection, if not enforced, can leave the species open to poaching, even in protected reserves. In spite of strict laws, the Tiger, for example, has been killed in national parks and reserves throughout its range, as a result of high prices paid for its body parts in Traditional Medicine. Thus, a species must receive many types of protection, from habitat to hunting and sale restrictions, combined with a strong protective attitude by people living within its range and elsewhere. Also, funding for research and habitat protection is a major factor that is often lacking for the less charismatic species, such as invertebrates and many plants. The reports generated in this project may consist of only a page or a long report, depending on the wishes of the teacher, student or individual participating in this project.

Methods

Answering as many of the questions listed below as possible concerning an individual species selected is the purpose of the project. It might be easiest to select a native species of animal or plant on the US Endangered Species Act or listed by state Natural Heritage Programs for information that is readily available, or a species about which books or reports have been written, such as the Gray Wolf, the Tiger or the Whooping Crane. One can contact the state Natural Heritage offices in care of each state capital, the US Endangered Species Office in Washington, DC, for federally listed species or the regional offices of the US Fish and Wildfire Service. The US Fish and Wildlife Service has a website as well (see the Organizations list in the Appendix). For information on birds threatened with extinction worldwide, *Threatened Birds of the World*, by BirdLife International, published in 2000 by Lynx Edicions, Barcelona, provides status and other background information, illustrations and references on more than 1,000 species of birds. *Mammals of the World*, by Ronald M. Nowak (1999, Sixth Edition, Johns Hopkins University Press), is another reference providing much of the information listed below. The *2000 IUCN Red List of Threatened Species*, available in CD-ROM disk and on the Internet (www.redlist.org), lists animals and plants of the world in various categories of threat along with basic background information. It is published by The Red List Programme Officer, 219c

Huntingdon Road, Cambridge CB3 0DL, UK; e-mail redlist@ssc-uk.org. Additional books and articles can be found in the Books and Publications Section of the Appendix of this book and in reference lists following each chapter. Within the text of *The Endangered Species Handbook* are many case histories that might provide background information as well. Read Traits of Vulnerable Species in Chapter 2, Vanishing Species**,** to better understand the importance of many of the following questions.

Activities

Answer the following questions with the best available information.

Part I. Description and Characteristics of the Species

1. Species common name, scientific name
2. Class and Family
3. Past range: in recent years and historically
4. Present range: country or countries, region or location
   Does the species have a small breeding range, but a large wintering range?
5. Is the species endemic to a restricted area or region**,** such as an island?
6. What type of habitat does the species inhabit? (For example, oceans, undammed rivers, lakes, old-growth forests, grasslands, mixed habitat.)
7. What is the approximate size of its territory? For example, Siberian Tigers may require 500 square miles per animal, while a small gazelle might survive in an area of only a few square miles. The territorial needs of a species are crucial to its conservation.
8. Does the species require a specialized habitat or diet? Is it adaptable to a variety of habitats or diets?
9. Does the species show altruism, or the unselfish care for members of its own kind?
10. What is the species longevity, if known?
11. What is the species rate of reproduction? (How many young or seeds does it produce, at what intervals and what is their survival?)
12. What is the species rate of natural mortality? (Does the species have few natural enemies or causes of mortality or do large numbers of the species die each year?)
13. Is the species a flightless bird or slow•moving animal? How does this affect its ability to defend itself against predators--human and animal?
14. Is this a large or small animal? The term is relative and denotes size that humans consider large, such as elephants, and other large ungulates, such as antelope, giraffes or rhinoceros, as opposed to small gazelles; for predators, Tigers are large as compared to Ocelots or Margays.
15. Does the species breed in colonies or require large numbers of its own kind for protection, to locate food sources or for other means of survival?

Part B. Status and Conservation

1. Status: What are the threats to this species' survival? (For example, habitat loss, effects of exotic species, trade or other causes.) Describe them in detail.
2. Population numbers, where known, past (historic) and present. (In most cases this would be general information, such as common and widespread

in the past, and small population numbers at present.)

3. Current situation: Is the species in steep decline, making its status Critical, or in gradual decline, making its status Vulnerable. Is its population stable, but threatened because of very small numbers?
4. If in decline, does the present rate of decline exceed annual recruitment by reproduction? If so, by how much?
5. Legal status: Is the species legally protected from killing, capture, sale and harm in all or a portion of its range? If a species is found in many countries, provide as much information as possible. If protected, is the protection enforced?
6. Status of habitat: Are there reserves or national parks protecting the habitat? Is the habitat being destroyed, or is land use compatible with the needs of the species?
7. What are the attitudes of most people who live in the range of the species toward it? Are they aware of its presence and status? If so, do they support its protection or are they neutral or even negative, persecuting it?
8. Adequacy of existing conservation: What is being done, either by governmental or private conservation organizations or individuals, to help the species survive? Is the present program effective? Is adequate funding available for its protection? What would be needed to better ensure its survival?
9. What are the potential threats to the species, such as future habitat destruction from expanding human settlements and government policies of land development? For example, the wildlife of India will be under increasing pressure as the population increases and wild habitat is destroyed. Government policies, such as resettlement of people or development of grassland or rivers for human use, can present major threats to wildlife. China, for example, is gradually resettling millions of people into the steppe grasslands of its far west who are having a negative effect on native wildlife and the environment. Through data in almanacs on the rate of human population growth**,** calculate the threat of habitat loss in the future.
10. Can you think of something that needs to be done for the species, such as research; publicity in the form of articles or a film about its status; increased commitment from government or organizations to its conservation; or a website on the Internet asking for more information and suggestions? Can you think of a way you or your class could help the species?

Biodiversity

Project Summary

Biodiversity is a term used to describe the numbers of species, families and other biological divisions of life forms on Earth. Studies of this subject in various parts of the world will be discussed. Certain regions and countries in the world harbor very large numbers of plant and animal species, yet these same areas are threatened by habitat destruction. What is being done to preserve such areas will be explored. The importance of preserving biodiversity to

human society and environmental balance is a major purpose of the project. A related topic integral to the study of biodiversity is the variety of ecosystems and environments that provide habitats for the great diversity of life on Earth and their protection.

Background

As studies of the natural world have blossomed over the past century, scientists have documented Earth's amazing array of plants and animals, each species interrelated with others in its environment. Although life exists even in inhospitable environments, such as frigid mountain tops and hot springs, certain ecosystems, primarily tropical forests and coral reefs, harbor the greatest diversity of species. Research on the species of plants and animals in these areas is just beginning, but remarkable findings have emerged. In a single tree in Peru, for example, Dr. Edward O. Wilson, a famed biodiversity expert and entomologist, found 43 species of ants, a number equal to all the species of ants found in the British Isles.

Studies of biodiversity have increased in recent years, and one country, Costa Rica, is now carrying out a biological inventory of all its species, a massive and important task that may take a century. A study that has gone on since the building of the Panama Canal measures the decline in the number of species living on Barro Colorado Island as the waters of the Panama Canal rose around it. It has documented the loss of many wide-ranging species as the range grew smaller. Such studies add to the understanding of habitat requirements for various species and how the loss of some affects ecosystems as a whole. A study in the Brazilian Amazon measured the biodiversity of an extensive rainforest prior to cutting it into parcels of varying size to determine the effects on species (see Lovejoy *et al.* 1984). As a result of extensive deforestation, especially in tropical countries, many studies of forest fragmentation and its effects on biological diversity are taking place, finding that losses of even a few species can result in major ecological damage (see Laurance and Bierregaard 1997 and description in the Forests chapter). Biodiversity studies known as RAPs, or Rapid Assessment Programs, last only a few days and seek to identify areas of high diversity that are in danger of being destroyed. "Environmental S.W.A.T Team" is a film about biologists who conduct one of these RAPS, inventorying a tropical forest for Conservation International, an organization which was able to convince the country's government to protect a threatened region based on the results of the study (see Video section).

Brazil's Atlantic Forest, one of the world's most diverse environments, which once covered millions of square miles along the southern coast and well inland, has been reduced by 92 percent. Remnants of this forest have been found to harbor the greatest diversity of trees in the world: 476 species in a plot of only 2.5 acres. By contrast, a plot of similar size in a North American temperate forest has fewer than 80 species of trees. This is known as a "hotspot," or an area of great biological diversity. Others include forests in the Andes, Madagascar and Indonesia (see Mittermeier *et al.* 1999). A vast array of plants and animals can be found in the hot spots, including many extremely unusual and unique examples of evolution that are in imminent danger of extinction. New Caledonia, for example, an island in the southwestern Pacific Ocean, is home to a variety of plants and animals of ancient origin. It is a small portion of Gondwana, the southern supercontinent that broke up into pieces some 140 million years ago at the dawn of the age of birds. The ancestors of the most primitive avian families originated in Gondwana, and the Kagu, a bird still resident on New Caledonia, is a direct descendant (see Cracraft 2001). Related to cranes, rails and bustards, the elegant, gray Kagu is flightless, with a stunning pattern of wing and head crest feathers. It possesses characteristics so unusual that it has been placed in its own avian family. The Kagu is threatened with extinction along with scores of other ancient species on New Caledonia, many of which had survived for millions of years (see *Threatened Birds of the World*). This hotspot is in grave danger of losing diversity to nickel mining, feral dogs that kill the Kagus and other wildlife, and deforestation.

The huge growth in human population over the past century, now totaling some 6.5 billion, is responsible for colonization of previously remote wilderness areas and for providing a market for the decimation of ancient forests and rare wildlife for commercial purposes. Land is being cleared for grazing livestock and farming, while mining, industry, corporate logging and other development are obliterating species throughout the world. Forests have the largest number of threatened species of any habitat, although the oceans have scarcely been explored for biodiversity. Tropical forests throughout the world harbor about half the world's plants and animals on only 7 percent of the planet's

land area. Hot spots also exist in temperate regions, such as the Appalachian mountains of the eastern United States, which have more types of salamanders than exist anywhere in the world, now threatened by pollution and logging. Rivers and waterways of the southeastern United States have the greatest number of mussel species in the world, but government dam and water projects have caused hundreds of extinctions. Grasslands, where only a century ago wild antelope, bison and other ungulates roamed in untold millions, have been converted into farms or pastureland for livestock, the wildlife killed off or driven away. In Earth's history, mass extinctions have occurred on at least five occasions, nearly obliterating the majority of life forms. These were natural events, but the present catastrophic situation is considered the sixth mass extinction, one that may end in destroying or seriously damaging the remaining rainforests, coral reefs and other precious centers of biodiversity within the next century (see Wilson 1988, Leakey and Lewin 1995). By some estimates, half of the estimated 5 million animals and plants that now exist, only a fraction of which have been scientifically identified, could be gone within a century.

Just as the diversity and ecological roles of species are beginning to be seen as components of an immense and beautiful living tapestry, the strands of this tapestry are unraveling. The disappearance of even a single species can result in extinctions of others dependent on it. For example, elephants and hornbills are the primary dispersers of many forest plant seeds, upon which a host of animals rely. Both are now in danger of extinction, threatening entire ecosystems. Thus, biodiversity is not an abstract concept, but a blueprint of the Earth's life forms. It is vital that its many parts be preserved. Once destroyed, many ecosystems, such as old-growth forests and other key environments, may never regenerate. In most such cases, our knowledge of diverse systems is inadequate to gauge just how many species--or which species--could disappear from an ecosystem before it collapses. Nor do we know how much genetic diversity a species can lose through loss of individuals before it can no longer adapt to changes in its environment. Drastic changes caused by human activities are outpacing research on such situations. The healthy functioning of ecosystems is key to human survival. Although the majority of biologists consider the loss of biodiversity to be the greatest problem facing humanity, few members of the public are even aware of this critical situation. Ignoring these experts' opinions of the precarious status of our planet's health, upon which our lives depend, is the equivalent of ignoring the opinion of a team of eminent doctors recommending urgent action to remedy an emergency medical condition.

Steps are being taken to preserve many critically important regions. Through acquisition of habitats and reintroductions of species, entire ecosystems are being saved. In a growing trend, countries are setting aside large new national parks and reserves. Suriname, for example, has established a national park that encompasses the central core of the country, covered in virgin rainforest and teeming with wildlife. Bolivia has set aside massive parks in areas with high biodiversity and unusual types of forests. Brazil, with the help of conservationists from around the world, is now working to save the last 8 percent of its Atlantic Forest in the southeast. Several countries in southern Africa are establishing international parks that greatly enlarge protected areas and allow migratory species, such as African Elephants and other ungulates, to move freely across borders. Corridors for wildlife to move from one area to another are also being established in the Americas. These prevent isolation of small populations of animals that would likely dwindle to extinction. Education is key to the future of preserving biodiversity, which is vital in maintaining the planet's ecological stability. Studies on this and related subjects are now being taught in an increasing number of high schools and colleges so that future generations will not squander the planet's true wealth, its natural heritage. Appreciation of the sheer beauty of the natural world and its wealth of species is an important facet of this project.

Activities

o **Biodiversity study.** Organize a group of students or interested persons to conduct biodiversity studies in your area. Ecosystems should range from low to high diversity. To study forest diversity, for example, you might select: (1) a small city park; (2) a suburban back yard or tree farm, and 3. a woodland, preferably old-growth. To study aquatic ecosystems, you might select: (1) a city creek or river; (2) a suburban pond, and (3) a sizeable natural wetland. The complexity of the project will depend on the experts available for identifying and recording species. The object will be to list as many species as possible from each area and provide a general description of the habitat. If there are rare, threatened or endangered species in any of the areas, these should be described and, if seen, carefully

noted. Invite employees of the state's Natural Heritage Program to help in selection of sites and, if possible, accompany the group. A biodiversity day in the Boston area attracted many scientists, including botanists, ornithologists, herpetologists and mammalogists, who educated interested members of the public at various sites. Experts in birds do not have to be ornithologists but can be proficient bird-watchers, knowledgeable in bird song as well as sight identification. If the field trip is taken during bird migration, note which species breed in the area and which are migrating through. Mammals, reptiles, amphibians and fish (if in an aquatic environment) are less readily seen, and specialists in the latter animals might demonstrate methods of live-trapping or locating these animals by turning over rocks or netting. The identification of trees and plants, including ferns, mosses and lichens, will provide basic information about the habitat. If experts in some or all of these fields are available, or the team leaders are able to provide basic information, the group can be divided into subgroups, each of which will choose a type of life form, such as plants, invertebrates, birds or mammals. Once back in the classroom or environmental center, the various groups can meet and provide lists of the species they have seen in each area. Any rare, endemic or endangered species will be singled out and described in detail. This one-day project will not provide a complete picture of the biodiversity of an area but can give a general picture that is valuable. The effects that development has on nature and the need to protect wilderness and natural areas will become apparent through such a study. In general, biological diversity increases the farther one gets from large cities and suburban areas. Keep in mind, however, that some extremely rare species, especially plants and insects, have managed to survive in small pockets of wild habitat in unexpected places. Weedy growth next to railroads, for example, has been found to harbor many rare plants and insects. Such areas, never cleared for development, have remained natural. Open space, even with low biological diversity, is preferable to asphalt, and students may contribute ideas on making city parks and suburban backyards more diverse by planting trees and shrubs and allowing brushy areas to grow. More advanced students can participate in the CD-ROM biodiversity study listed below (see Wilson and Perlman 1999).

o **Bird feeding.** Another project involves appreciation of biodiversity with the potential for making a contribution to ornithology. Backyard bird feeders can provide an eye-opening education in biodiversity that is also extremely enjoyable. Bird feeders attract many common seed-eating birds. Adding suet and fruit can bring woodpeckers, orioles and other fruit-eating birds. The number of species that come to bird feeders is related to the habitat and surrounding area. Feeders in remote habitats or located on bird migratory flyways will attract more species than those placed in the city, which are likely to attract pigeons, sparrows and starlings, all European in origin. Sometimes, a rare species comes to the bird feeder to feed or is attracted as a predator on the birds. Bird feeders can provide important data on bird diversity and population trends. Cornell's Laboratory of Ornithology (159 Sapsucker Woods Road, Ithaca, NY 14850-1999 (Tel: 607-254-2473) conducts a program that enrolls volunteers to keep track of the birds that visit their feeders. By providing a wide variety of seed and other food, one can learn much about diets, how the birds feed, their behavior and plumage changes throughout the year. Books about bird feeding are sold in most book stores, and local chapters of the National Audubon Society provide information on feeders and feed. Television advice is given by Don and Lillian Stokes in their PBS series.

o **Bird-watching.** Bird-watching trips are important in learning about the majority of species that do not come to bird feeders or live in suburban backyards. Insect-eaters, such as warblers, flycatchers, vireos and other songbirds, can be seen only on migration or in their natural environments. During migration, especially in the spring, the beauty of these colorful birds, called "living jewels" by many naturalists, can be appreciated by using binoculars. Excursions to various habitats to see birds will also teach the diversity of environments, threats to them, and which types harbor the greatest diversity of birds. Local bird clubs, National Audubon Society chapters and naturalist clubs are sources of information on the best birding spots and times of year when one is likely to see the greatest number of birds. Many of these organizations conduct birding trips, both in the United States and in foreign countries. Declines in avian diversity and in population numbers will become evident after participation in several of these trips. Sources of information on such trends include trip guides who have been conducting tours or breeding bird surveys of the US Fish and Wildlife Service or the National Audubon Society over a period of years in the same habitat. Ask them for information on species that have declined or disappeared altogether as a result of environmental changes, pollution or other causes. Note the species of birds seen on the trip and find out from the guide or other authority, such as the US Fish and Wildlife Service or National Audubon Society, whether these species have declined over recent years. For

example, shorebirds seen on coastlines or in the Mississippi River region have suffered dramatic losses of up to 90 percent in some species over the past 30 years. The causes are diverse, from overfishing of food sources, disturbance of beach nesting areas, loss of habitat in wintering or nesting grounds to killing on their wintering grounds. On the list of species seen, note population trends and their causes in the area visited.

o **Worldwide perspective.** Learning about biodiversity from a worldwide perspective is key to understanding the subject. Dr. Edward O. Wilson of Harvard University coined the word "biodiversity" in the 1988 book of that title that he edited. His other book on the subject is also a primary resource. Both give overviews of the world's wealth of species and risks to them. Another important basic reference, *Conserving Biological Diversity*, by Jeff McNeely and other authors, is a 1990 overview of the problem, with key species and regions described. This leads to *Hotspots*, written a decade later in 2000 by Dr. R.A. Mittermeier and others. This book identifies hotspots as the world's most endangered high-biodiversity areas and discusses each in terms of geography; habitat; which species are native, especially those that are found only that in particular area (endemic species); statistical biodiversity for each area; threats to the area; and what is being done to conserve them. Clive Ponting's *A Green History of the World* helps explain why past civilizations have died out as a result of ignorance and overexploitation of their environment and the native wildlife upon which they depended. Michael J. Novacek of the American Museum of Natural History edited a 2001 book, *The Biodiversity Crisis. Losing What Counts*, a collection of essays by prominent scientists and conservationists who discuss the increasing rate of extinctions and give case history examples of areas at risk and what strategies are working to help protect them. The other references listed below provide additional information.

- Write an essay on the problem of the loss of biodiversity, emphasizing the reasons why it is important to the future of human society, as well as for the sake of conservation.
- List ways that consumers in the United States who buy tropical hardwoods and other goods, use large amounts of non-renewable energy and produce greenhouse gases, affect the loss of biodiversity.
- Choose a country or area that has high biodiversity, such as Colombia, Madagascar or Indonesia, and describe the geography, climate, type(s) of biological diversity, threats, unique species of plants and animals, conservation programs, and whether they are successful. Calculate the losses of species should the present rate of deforestation or other destruction continue, using references such as *Hotspots* and *Threatened Birds of the World.*

o **Species in danger.** Learning about threatened plants, birds, mammals and other species will provide in-depth knowledge of what is at stake. *Threatened Birds of the World* examines the 1,100 species whose future survival is in danger. This book illustrates each species with range maps, status and other background information. Many of these birds are illustrated in *The Life of Birds,* a book by David Attenborough, and in a 10-hour film series based on it seen on PBS. The Video section describes other films about threatened species. Other threatened animals and plants surveyed by the *2000 IUCN Red List of Threatened Species* are not described in depth by the International Union for the Conservation of Nature and Natural Resources (IUCN), which sponsors this list. The IUCN no longer publishes "Red Data Books," which gave background information on each species. The Internet site (www.redlist.org) provides some information, such as distribution and basic status category, but few listings give causes of the status and other related data. Such information gaps are filled in part by publications such as *Walker's Mammals of the World,* a two-volume, in-depth examination of mammals by Dr. Ronald Nowak, regularly updated and last issued in 1999. The IUCN Species Survival Commission sponsors many individual specialist groups that gather information on elephants, rhinos, whales, primates and many other categories. These groups issue newsletters and have websites. (Contact the SSC Red List Programme Officer, 219c Huntingdon Road, Cambridge CB3 0DL, UK; e-mail redlist@ssc-uk.org). Select a group of species, such as salamanders, frogs or orchids, and describe their general status. How many species are threatened? What are the general causes? What areas of the world do they inhabit? What will be the effect on other animals or plants in their ecosystems should they disappear? What should be done to preserve them?

Books and Publications
Video

Biodiversity: Books and Publications

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and Plants of Our World. Harper Perennial, Division of Harper Collins, Publisher, New York, 285 pages.
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Hoose, P.M. 1981. *Building an Ark: Tools for the Preservation of Natural Diversity Through Land Protection*. Island Press, Covelo, CA, 212 pages.
Howes, Chris. 1997. *The Spice of Life. Biodiversity and the Extinction Crisis.* Blandford, A Cassell Imprint, London, UK, 192 pages.
Huston, M.A. 1994. *Biological Diversity: The Coexistence of Species on Changing Landscapes*. Cambridge University Press, Cambridge, UK.
Karliner, Joshua. 1997. *The Corporate Planet. Ecology and Politics in the Age of Globalization.* Sierra Club Books, San Francisco, CA, 298 pages.
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Laurance, W.F. and R.O. Bierregaard, Jr. (eds.). 1997. *Tropical Forest Remnants. Ecology, Management and Conservation of Fragmented Communities.* University of Chicago Press, Chicago, IL.
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Miller, K.R. 1980. *Planning National Parks for Ecodevelopment*. University of Michigan, Ann Arbor, MI.
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Noss, Reed F. and Allen Y. Cooperrider. 1994. *Saving Nature's Legacy. Protecting and Restoring Biodiversity.* Island Press, Washington, DC, 443 pages.
Novacek, Michael J. (ed.). 2001. *The Biodiversity Crisis. Losing What Counts.*

An American Museum of Natural History Book, The New Press, New York, 224 pages.
Nowak, Ronald M. 1999. *Walker's Mammals of the World.* Vols. I and II. Johns Hopkins University Press, Baltimore, MD.
Ponting, Clive. 1991. *A Green History of the World. The Environment and the Collapse of Great Civilizations*. Penguin Books, New York, 432 pages. (How civilizations have died out after they destroyed their environments.)
Peters, C.M., A.H. Gentry and R.O. Mendelsohn. 1989. Economic valuation of an Amazonian rainforest. *Nature*, 339:655-656.
Peters, R.L. and T.E. Lovejoy. 1992. *Global Warming and Biological Diversity*. Yale University Press, New Haven, CT.
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Rich, Bruce. 1994. *Mortgaging the Earth. The World Bank, Environmental Impoverishment, and the Crisis of Development*. Beacon Press, Boston, MA, 376 pages.
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Terborgh, John. 1999. *Requiem for Nature.* Island Press, Shearwater Books, Washington, DC, 234 pages. (Examines Manu National Park, Peru, and others as examples of the failure of present land protection programs to preserve biodiversity, and proposes alternative solutions.)
Turner, B.L. II, William C. Clark, Robert W. Kates, John F. Richards, Jessica T. Mathews and William B. Meyer (eds.). 1990. *The Earth as Transformed by Human Action. Global and Regional Changes in the Biosphere over the Past 300 Years*. Cambridge University Press, Cambridge, UK, 713 pages.
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Wilson, Edward O. 1992. *The Diversity of Life*. W.W. Norton & Co., New York, 424 pages.
Wilson, Edward O. and Dan L. Perlman. 1999. *Conserving Earth's Biodiversity.* Island Press, Covelo, CA. (Interactive CD-ROM that teaches conservation biology and environmental science; teachers may view demo at www.Islandpress.org/wilsoncd/ and register for an examination copy.)
Wolf, Edward C. 1987. *On the Brink of Extinction: Conserving the Diversity of Life*. Worldwatch Institute, Washington, DC.

Biodiversity: Video

"Biodiversity: The Variety of Life" explains what biodiversity is and why we should protect it. This film uses maps,

diagrams and examples to introduce new terms and concepts, including fragmentation, linkage, and viable population, to explain how ecosystems are dynamic and varied. It focuses on the North Cascades ecosystem, but presents general concepts.

"State of the Planet" is a 3-hour BBC Bristol film on the biodiversity crisis made for Discovery Communications in 2000. It examines the rise in extinctions and endangered species and causes such as "islandization" or isolation of habitat surrounded by development; it profiles Hawaii as leading the world in extinct and endangered species, its beautiful natural heritage being destroyed by exotic species and disappearance of native forests. The final hour of this film series, "The Future of Life," makes clear that if we do not act soon, great natural treasures will be lost.

"Natural Connections," produced by Howard Rosen for PBS in 2000, is a one-hour examination of the failure of the United States and other developed countries to protect nature. It links extravagant and unthinking lifestyles with the loss of biodiversity and proposes changes that will have direct effects in terms of preserving species.

Bats: Ecologically Important Mammals

Project Summary

Learning about bats and threats to them is the major purpose of this project, as well as understanding the importance of bats to the environment as pollinators, seed dispersers and insect-eaters. An endangered bat species will be selected as the subject of a report. Conservation of bats through the protection of their habitats and building of bat houses will be an important facet of this project.

Background

Bats comprise almost one-fourth of all mammals--nearly 1,000 species--yet they have not received the attention and credit they deserve as major insect-controllers and pollinators in ecosystems worldwide. Many species are becoming endangered, and others are declining from destruction of their nesting caves, direct persecution from ignorance, closure of mines which many bats had colonized, and indiscriminate use of pesticides.

Until recently, bats were routinely poisoned by commercial pest control companies in the mistaken idea that all bats pose the threat of rabies transmission. Only one-half of 1 percent of bats contract rabies. Over the past 45 years, only 20 people in the United States and Canada have contracted the disease from bats, according to Bat Conservation International, an organization dedicated to the conservation of bats and education about their ecological roles. Most problems involve people carelessly picking up obviously sick bats found out in the open or on the ground in the daytime. These should always be avoided, according to Dr. Merlin D. Tuttle, Founder and Executive Director of Bat Conservation International. Pest control companies in the United States are now adopting new and more informed policies regarding the removal of unwanted bats from buildings. The journal *Pest Management,* in its May 1992 edition, published several articles on how to "bat-proof" buildings without use of lethal means, and the usefulness of bats in controlling insects.

A single Brown Bat, one of North America's most common species, is capable of capturing 600 mosquitoes in an hour (see Tuttle and Smith referenced below). One colony of 20 million Mexican Free-tailed Bats in central Texas eats a quarter of a million pounds or more of insects each night, according to Bat Conservation International. Repercussions have occurred when bats have been destroyed. In Israel, a campaign to eradicate fruit bats instead killed almost 90 percent of the country's insectivorous bats; moths that were formerly controlled by the bats proliferated and became major agricultural pests (Tuttle and Smith). To control these pests, huge amounts of pesticides were used, further eliminating natural predators of insects and beneficial insects.

Nectar-feeding and fruit bats pollinate more than 130 genera of plants. The co-evolution of many bats and plants, the

latter evolving prominent, odoriferous large flowers blooming at night with copious nectar and pollen, and the former specialized tongues and muzzles for flower-feeding and acute senses of sight and smell, is a fascinating study in itself. The statuesque Century Plant of southwestern deserts has co-evolved with a pollinating bat, and this plant blooms at rare intervals, using nectar to attract its pollinator (see Howell referenced below). Among plants that bats pollinate are valuable fruits, nuts and spices: plantain, bananas, breadfruit, mangos, guavas, avocados, almonds, cashews, cloves, vanillin, carob and figs. In Southeast Asia, a bat that pollinates the Durian tree, which produces fruit marketed for $120 million per year, is being killed for food and its caves quarried for limestone. Few people in the region are aware of its economic importance and the need to conserve it. Fruit bats throughout the world are killed for food, and a growing number are becoming endangered.

Many US bats are listed on the US Endangered Species Act as Endangered or Threatened or on the *2000 IUCN Red List of Threatened Species*. The Indiana Bat's entire population winters in only a few caves in the United States. Approximately 95 percent of the entire known Gray Bat population hibernates in only nine caves with more than half in a single cave in northern Alabama. The threatened Rafinesques Big-eared Bat is found only in Indiana, but it receives no federal protection from the US Endangered Species Act. The Nature Conservancy and many state Natural Heritage Programs have been instrumental in purchasing numerous caves to protect these species.

The following bats are either listed on the US Endangered Species Act or on the *2000 IUCN Red List of Threatened Species*. Some experts estimate that approximately 40 percent of US bats are declining or already endangered. Many species recognized by mammalogists as threatened or endangered and listed by the IUCN as Vulnerable, a high category of risk, have not been listed on the US Endangered Species Act.

Threatened United States Bats
(Includes territories)

Key:
E = Endangered
NT = Near Threatened
T = Threatened
V = Vulnerable
X = Extinct

For definitions of these categories, see the list of Endangered and Threatened Mammals, Birds, Reptiles and Amphibians in the Appendix of this book.

Species	Distribution	US ESA	IUCN Red List
Big Long-nosed Bat *Leptonycteris nivalis*	US, Mexico, Guatemala	E	E
Brazilian Free-tailed Bat *Tadarida brasiliensis*	sw US to S. America		NT
California Leaf-nosed Bat *Macrotus californicus*	US, Mexico		V
Gray Bat *Myotis grisecens*	c. & se US	E	E
Hairy-legged Vampire Bat *Diphylla ecaudata*	US, Mexico to Peru		NT
Hawaiian Hoary Bat *Lasiurus cinereus semotus*	US (Hawaii)	E	

Hog-nosed Bat *Choeronycteris mexicana*	US, Mexico, C. America		NT
Indiana Bat *Myotis sodalis*	e. & Midwest US	E	E
Lesser Long-nosed Bat *Leptonycteris curasoae*	US to S. America		V
Sanborn's *L.c. yerbabuenae*		E	
Little Mariana Flying Fox *Pteropus tokudae*	Guam	E	X
Marianas Flying-fox *Pteropus mariannus*	SW Pacific		E
Guam *P.m.mariannus*		E	
Mexican Long-nosed Bat, see Big Long-nosed Bat			
Rafinesque's Big-eared Bat *Plecotus rafinesquii*	US (Indiana)		V
Townsend's Big-eared Bat *Plecotus townsendii*	US		V
Ozark *Plecotus townsnedii ingens*		E	
Virginia *Plecotus townsendii virginia*		E	
Underwood's Mastiff Bat *Eumops underwoodi*	US to Central America		NT

In addition, each state Natural Heritage Program has a list of threatened or rare mammals, many of which include bats. The major threats to bats in North America are similar to those in foreign countries. They include the cutting of old-growth forests that provide habitat, pesticide use, deliberate poisoning and destruction of caves where many bats winter.

Activities

o Find out which bats live in your area. For distribution information, consult guide books such as *North American Mammals*, published by the National Audubon Society. Use reference books such as *Bats*, by M. Brock Fenton (1992), *America's Neighborhood Bats*, by Merlin D. Tuttle (1988), and *Walker's Mammals of the World*, by Ronald Nowak. Bat Conservation International has published a beautiful brochure, "Bats: Gentle Friends, Essential Allies," and a fact sheet, "Important Bat Facts." Different species of bats can occupy the same general area, yet have different diets and habitats. How do the bats in your area differ in these ways? What do they eat? Contact the Natural Heritage Program of your state and ask them if there are important bat habitats, such as caves, that are endangered and how your class or local organization can help save these habitats.

o Select a threatened species of bat and write a report on its status, life history, threats and what is being done for its conservation. Consult the references below and your state's Natural Heritage Program.

o Discuss the ecological importance of bats. What fruits and other plants important to humans are pollinated by

bats? What would be the effect on insect populations if bats disappeared? *Bats in Question*, by Don E. Wilson, listed below, is a very useful book for information on this subject.

o Help dispel the image of bats as dangerous, rabid creatures who should be eliminated. Humane means of keeping bats from entering buildings exist, and local animal control officials and public health officials should be provided with such information, available from Bat Conservation International. Also, letters to the editor of your local newspaper can be helpful, especially if an article about rabies or vampire bats has been printed. Point out that bats are extremely beneficial and vital to the survival of many plants.

o Build a bat house as a class project. The instructions for construction and placement are given in "The Bat House Builder's Handbook" from Bat Conservation International and a video that gives instructions and general information. This pattern prevents mortality to bats from improper design, materials and placement. Once constructed, calculate the number and species of bats that will occupy the house(s) and the number of insects they will consume.

o Bats have many highly unusual characteristics. Many have echo-location sonar far more sensitive than that designed by humans. Others are able to hunt unusual prey, such as fish or frogs. Their abilities are so finely developed that they are only beginning to be understood. They also are intelligent and devoted to one another. They are among the few species who aid one another during the birthing process, as "animal midwives." Consult the books and films listed below and write a paper on a particular trait that you find fascinating.

Books and Publications

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Howell, Donna J. 1976. Plant-loving Bats, Bat-loving Plants. *Natural History* (magazine of the American Museum of Natural History, New York), Feb.
Nowak, Ronald M. 1999. *Walker's Mammals of the World* (Volume I), Johns Hopkins University Press, Baltimore, MD. *(Walker's Bats of the World*, another reference by the same author, is derived from the latter volume.)
Tuttle, Merlin D. 1988. *America's Neighborhood Bats*. University of Texas Press, Austin, TX.
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Wilson, Don E. 1997. *Bats in Question. The Smithsonian Answer Book*. Smithsonian Institution Press, Washington, DC. (Source book with questions and answers about bats and superb photography by Merlin D. Tuttle; addresses of organizations concerned with bat conservation are listed at the end of the book along with a list of all bats with their conservation status.)

Films

"Korup. An African Rain Forest." A Cameroon forest where bats are seen pollinating flowers at night.
"The Secret World of Bats." Overall view with the role of bats as pollinators and insect-eaters is stressed, and unusual species, such as fish-eating and threatened fruit bats, are seen.
"Wet Side Story." Central American rainforest with bats as a focal point. The sensitivity of their sonar is beautifully filmed.
"Private Life of Plants." Includes pollination by bats of several species of plants and describes how plants and bats co-evolved.
"Castaways of Sulawesi." An Indonesian island is the scene of cruel capture

of flying foxes for sale as food by young boys using hooks on kites that entangle them in flight.

The films above are described in detail in the Video section of this book.
In addition, other films that focus on bats include "Phantom of the Night" (bats of Central America); "Beneficial Bats" (Wild America series); "Land of the Giant Bats" (Comoros flying foxes); "Life Upside Down" (Quebec Government film emphasizing Canadian bats and their ecological role); "Night Stalkers" (bats of Belize--National Geographic Explorer TV program).

Slide Show
"Bats of America," by Bat Conservation International.

Further Information
Bat Conservation International, P.O. Box 162603, Austin, TX 78716; website: www.batcom.org
US Fish and Wildlife Service, Office of Endangered Species, Washington, DC 20240
State Natural Heritage Programs

Internet: e-mail discussion "Batline"--batline@unmvma.unm.edu

Conserving the Wood Thrush

Project Summary
Learn about the life history, distribution, ecology and conservation of the Wood Thrush, a songbird in steep decline. Using written materials and sources listed below, write a report on the threats it faces and what is needed to help it survive. For those who live in areas where the Wood Thrush is not native, select another declining songbird and follow the same suggestions.

Background
The Wood Thrush (*Catharus mustelinus*) is one of the most melodious songbirds in the world. Its beautiful, fluted song echoes through eastern North America's woodlands. In the words of Arthur Cleveland Bent, author of a series of authoritative life history studies of American birds: "The nature lover who has missed hearing the musical bell-like notes of the wood thrush, in the quiet woods of early morning or in the twilight, has missed a rare treat. The woods seem to have been transformed into a cathedral where peace and serenity abide. One's spirit seems truly to have been lifted by this experience."

The Wood Thrush is also useful to forest ecosystems, consuming vast amounts of insects. Unfortunately, its populations have declined in recent years from 40 to 80 percent, depending on the area. Major causes include the destruction of both its nesting and wintering forests, combined with parasitism on its nests by the Brown-headed Cowbird, a bird that lays its eggs in the nests of other birds. These eggs tend to be larger than the eggs laid by the Wood Thrush, and the aggressive chicks crowd out the thrush chicks. Wood Thrushes are closely related to the familiar American Robin, a common denizen of suburban yards and forests. Unlike the Robin, however, the Wood Thrush is not common in suburbs and backyards. Although the species was occasionally seen near homes and villages in the first half of the 20th century, today it breeds only in undisturbed forest tracts. Its forest habitats have become fragmented into smaller and smaller blocks, causing the species to disappear from many areas.
Wood Thrushes migrate to Mexico and Central America each winter. They seek out old-growth rainforests from southern Mexico through Panama. Within the past 40 years, their forests have been logged and often converted into

grazing land or agricultural fields. Researchers tracking these birds to their wintering grounds have discovered that they stay in the same area, even though it has been destroyed, and usually die within a short period from starvation or predation. The decline in this species' population was discovered through Breeding Bird Surveys conducted annually by the US Department of Interior. The Wood Thrush is close to endangered status, and conservation is critical to prevent its decline to extinction.

Other North American songbirds that migrate to tropical areas have declined as well. These birds, known as neotropical migrants, include tanagers, orioles, warblers, thrushes and vireos. These colorful birds brighten our forests and orchards, consume harmful insects and play important ecological roles. Almost all are in decline, some far more precipitously than others.

Activities

o Find out about the Wood Thrush, using the text in this book (see index), sources listed below and those available in your library and through computer on-line searches.

o Write a report answering as many of these questions as possible:
- What does the Wood Thrush look like?
- How large is it?
- Are males and females different in size or appearance?
- What is its diet?
- What type of woods does it prefer (for example, dry, old-growth forest or cool, damp forest near streams)?
- Does it build its nest on the ground, in bushes, or on tree branches?
- How large a territory does it establish?
- When does it sing? Describe its song (see reference on obtaining recording).
- How long does it live?
- What are its breeding and wintering ranges?
- How did early naturalists, such as John James Audubon, describe Wood Thrushes in the 19th century? (See Audubon and Coues book below.)
- How serious is the threat from Brown-headed Cowbirds who lay their eggs in Wood Thrush nests? (This was noted even in the 1930s by Bent (1964), and later by other authors such as Rappole *et al.* (1989), and Terborgh (1989.)
- How can people contribute to protecting both the breeding and wintering habitat of the Wood Thrush?

o Field study**:** If you live east of the Mississippi River in the range of this species, visit an area where Wood Thrushes live**.** First, listen to the recording of their songs (see below). Often they are more easily heard than seen. Do not approach a nest or disturb birds by playing recordings of their songs. Photograph the woodland setting where you hear the Wood Thrushes and try to observe them quietly from a distance. Describe what wildflowers, trees and other birds you see. If you live outside their range, see films listed below and listen to recordings or select another species of thrush or songbird found in your area that is in decline as a result of habitat loss, especially forests. Consult your local Audubon Society, the US Fish and Wildlife Service, your state's Natural Heritage Program or the bird count programs listed below.

o Conservation project**:** Find out if there is a woodland near your home where Wood Thrushes breed. The local National Audubon Society or birding organization can provide this information. If so, is it protected from logging? Can your class or school help in protecting a woodland where they breed?

o Participate in a survey of native birds through programs sponsored by local Audubon or birding organizations. The

American Birding Association publishes an annual guide, "Volunteer Opportunities for Birders," which lists day-long programs and more extensive studies. Available for $2 from Volunteer Directory, ABA Sales, P.O. Box 6599, Colorado Springs, CO 80934; 800-634-7736. For further ideas, see Nickens reference below.

o Why are some species rare and others common? Compare the Wood Thrush with the American Robin by answering the following questions: Does the Robin migrate? If so, where does it migrate? Are there dangers in its wintering ground, such as deforestation? Where does the Robin nest? Is there more habitat for American Robins or for Wood Thrushes? Explain why. Are there threats to the American Robin?

Books and Publications

Adams, George. 1994. *Birdscaping Your Garden. A Practical Guide to Backyard Birds and the Plants that Attract Them.* Rodale Press, Emmaus, PA. (On page 87, the Wood Thrush is profiled, providing information about migration, breeding range, nesting, feeding, garden bushes and fruiting plants that it will eat, as well as the woodland habitat it prefers.)

Audubon, Maria R. and Elliott Coues. 1986. *Audubon and His Journals*. Vols. I and II. Dover Publications, New York. (First published in 1897, Audubon's journals were collected by Maria Audubon with notes by the distinguished naturalist Elliott Coues. Wood Thrushes are mentioned many times.)

Bent, Arthur C. *Life Histories of North American Thrushes, Kinglets, and Their Allies.* First published in 1949 and reprinted by Dover Publications, New York, 1964, pages 101-122.

Bull, John and John Farrand, Jr. 1977. *The Audubon Society Field Guide to North American Birds. Eastern Region.* Alfred A. Knopf, New York. (A photo guide.)

Cherry, Lynne. 1997. *Flute's Journey. The Life of a Wood Thrush*. A Gulliver Green Book. Harcourt Brace and Company, San Diego, CA; New York.

DeGraaf, Richard M. and John H. Rappole. 1995. *Neotropical Migratory Birds. Natural History, Distribution, and Population Changes*. Comstock Press, Cornell University, Ithaca, NY. (This book has range maps of all North American breeding birds that migrate to Latin America and several pages of discussion of each species.)

Farrand, John Jr. (ed.). 1983. *The Audubon Society Master Guide to Birding.* (Has color photo of adult at nest with chicks and a color painting of the juvenile.)

Forbush, Edward Howe and John Bichard May. 1959. *A Natural History of a Bird of Eastern and Central North America*. Bramhall House, New York, pages 377-378.

Geffen, Alice M. 1978. *A Birdwatcher's Guide to the Eastern United States*. Barron's, Woodbury, NY. (This and the Pettingill book below list major parks, refuges and public lands by state; under each is a list of birds to be seen.)

Hagan, John M. III and David W. Johnston (eds.). 1992. *Ecology and Conservation of Neotropical Migrant Landbirds*. Smithsonian Institution Press, Washington, DC. (This book is not indexed. It is a collection of papers from a 1989 symposium, containing much information on the problems of songbirds, including the Wood Thrush, especially an article on destruction of its habitat in Veracruz, Mexico, on pages 337-344.)

Harrison, Colin. 1978. *A Field Guide to the Nests, Eggs and Nestlings of North American Birds.* The Stephen Greene Press, Brattleboro, VT; Lexington, MA. (This book describes the nest and nestlings and gives the nesting dates; a color photo shows the egg.)

Keast, Allen and Eugene S. Morton (eds.). 1980. *Migrant Birds in the Neotropics: Ecology, Behavior, Distribution and Conservation*. Smithsonian Institution Press, Washington, DC. (Papers submitted at a symposium. Many discuss the threats that migrant songbirds, including Wood Thrushes, face on their wintering range. The introduction gives an overview of the songbird decline.)

Kricher, John C. 1988. *A Field Guide to the Ecology of Eastern Forests. North America*. The Peterson Field Guide Series. Houghton Mifflin Co., Boston, MA. (This book contains information on hundreds of species of plants and animals, many of which are illustrated with color photos.)

National Audubon Society Nature Guides. *North American's Eastern Forests and Wetlands*. Alfred A. Knopf, New York.

Nickens, Eddie. 1997. Beyond the Life List. *Wildlife Conservation* magazine, July/August. (Wildlife Conservation Society, Bronx Zoo, Bronx, NY 10460.)
(This article describes the work of volunteers who participate in surveys, banding, birdfeeder studies and other projects relating to North American songbirds; it provides addresses and phone numbers of various organizations.)

Peterson, Roger Tory. *A Field Guide to the Birds. A Complete Guide to All the Birds of Eastern and Central North America*. Houghton Mifflin Co., Boston, MA. (This classic guide has excellent illustrations, breeding range map and descriptions.)

Pettingill, Olin Sewall, Jr. 1977. *A Guide to Bird Finding East of the Mississippi*. Oxford University Press, New York. (Although many of the areas described in this indexed book have changed since it was first written, many are protected sanctuaries, parks and reserves.)

Rappole, John H., Eugene S. Morton, Thomas E. Lovejoy III and James L. Ruos. 1983. *Nearctic Avian Migrants in the Neotropics*. US Fish and Wildlife Service and World Wildlife Fund, Washington, DC. (This publication is not indexed, but is a well-organized report on North American songbirds, their ecology and threats. Range maps show breeding range as well as wintering range of all migratory species.)

Sibley, David A. 2000. *The Sibley Guide to Birds*. Alfred A. Knopf, New York. (Considered one of most inclusive guides because it includes information on subspecies, varieties and other aspects not covered in most guides.)

Stokes, Donald and Lillian. 1996. *Stokes Field Guide to Birds. Eastern Region.* Little, Brown & Co., Boston, MA. (Color photos.)

Terborgh, John. 1989. *Where Have All The Birds Gone?* Princeton University Press, Princeton, NJ. (Many mentions in the text, see index; this is a landmark book on the decline in North American songbirds, exploring their problems on both the breeding and wintering grounds)

Yoon, C.K. 1994. More Than Decoration, Songbirds Are Essential to Forests' Health. *The New York Times*, Nov. 8.

Organizations and Governments

National Audubon Society, 700 Broadway, New York, NY 10003. (212-979-3000); or local chapters.

Conservation International, 1015 18th St., NW, Suite 1000, Washington, DC 20036.

Cornell Laboratory of Ornithology (Breeding Bird Censuses), 159 Sapsucker Woods Rd., Ithaca, NY 14850-1999 (607-254-2473).

Institute for Bird Populations, P.O. Box 1346, Point Reyes Station, CA 94956; (415-663-1436).
The Nature Conservancy, 1815 North Lynn St., Arlington, VA 22209 (and field offices throughout the country).
Natural Heritage Programs in every state in Department of Wildlife or Fish and Game.
US Fish and Wildlife Service, 4401 N. Fairfax Dr., Arlington, VA 22203.
Breeding Bird Survey, Biological Resources Division, US Geological Survey, Patuxent Wildlife Research Center, 12100 Beech Forest Rd., Laurel, MD 20708.
Fish and Wildlife Reference Service, 5430 Grosvenor Lane, Suite 110, Bethesda, MD 20814 (800-582-3421).

Recordings

The Peterson Field Guide Series. A Field Guide to Bird Songs of Eastern and Central North America, recorded by the Cornell Laboratory of Ornithology. 2nd edition. Houghton Mifflin Co., Boston, MA. 1983. Two tape cassettes. (Wood Thrush on Side 3, Band 4). Other recordings, such as the Stokes audio guides, are also available.

Films

"On a Wing and a Song." This Canadian Broadcasting Company film gives an overview of the songbird decline in Eastern North America, illustrating the vast areas of boreal forest where many of these birds nest in Canada, which has been logged. It addresses the loss of habitat in their tropical wintering grounds; the millions killed by colliding with skyscrapers and antennas during migration; and the parasitism by cowbirds.
"On a Wing and a Prayer." A similar title to the above film, this film focuses on an Illinois woodland and the decline in songbirds, primarily Wood Thrushes. The parasitism by cowbirds is dramatically shown: Wood Thrush chicks starve to death next to huge, fat cowbird chicks. This film also has a teacher's guide.
(See Video section for more detail and distributor list.)

North America in the Year 1400

Project Summary and Background

North America has changed radically since 1400, prior to the arrival of Europeans. It was then a continent without roads, skyscrapers, massive farms and other signs of modern life. This project involves research to discover what the country looked like at this early date, how areas such as the eastern forests, prairies and western forests have changed, and what species of animals and plants disappeared or became threatened as a result of changes to their environment or losses in their populations from other causes.

Activities

o Read the section in this book entitled "Epitaphs for North America's Lost Species and Environments" in Chapter 1.

o Using this and other sources mentioned in the reference list and in local libraries, select an area somewhere in North America. Some possible choices are the following: Cape Cod, Massachusetts; the Chesapeake Bay; eastern old-growth forests; long-grass prairies of the Midwest; short-grass prairies of the West; Sequoia or Redwood forests of

California; or the Mojave Desert in California. If there are parks in the area you choose, contact the park directors, conservation organizations and museums for natural history information.

- Describe the landscape as it was prior to the arrival of Europeans, without roads, modern buildings or other signs of the 20th century. What was the habitat like? Was it forest, mountain, grassland, desert, wetland, river or a combination of these? Were there beautiful vistas or dense woodlands with tangled vegetation? Describe a typical scene in the area you have chosen. For example, in a short-grass prairie, a herd of American Bison graze while, in the background, Pronghorn antelope run in close formation. On a distant hilltop, a pack of Gray Wolves watches the scene while a Grizzly Bear ambles through the low shrubs, looking for ripe berries. Overhead, flocks of Whooping Cranes soar, trumpeting to one another; and near a prairie dog town, grouse display in an open area, issuing booming calls.

- What species of mammals live here? If there are herds of deer, what species are they? Are there American Bison, Elk, Moose, Bighorn Sheep or Pronghorn? What kind of predators prey on these animals?

- Describe what bird species inhabit the area and whether they are abundant or rare. Are there Passenger Pigeons or Carolina Parakeets?

- What other kinds of animals are native? What reptiles, amphibians and fish, for example, inhabit the area? Apply the same questions about life history, habitats, reproduction and feeding.

- How do these animals interact ecologically? For example, if a western short-grass prairie were chosen, the prairie dog colony has abundant wildlife living underground in the burrows, including Black-footed Ferrets, Burrowing Owls, snakes and tortoises. Bison and other grazing animals feed on the grasses above, made greener by the cropping of the prairie dogs. Which species are the predators, and which the prey?

- Is there a tribe of Native Americans who live in this area? What is the name of the tribe? Are they nomadic, or have they established a permanent settlement? Are they hunters, fishers or farmers? What animals do they hunt or fish, or which crops are grown? What are their beliefs about the natural world and wildlife?

o Based on these descriptions of a past landscape, become acquainted with the present landscape and discuss the following:

- How has the natural environment changed? How does it appear today?

- What species no longer live here? Which ones are extinct altogether? (Check the list of extinct species in the Appendix and publications in the Books and Publications section on extinctions and extinct species accounts.)

- What do you think has been lost that should have been protected?

- Are there parts of this area that have not changed and remain as they were 600 years ago?

- Are there people or organizations working to preserve or restore parts of the original landscape and wildlife? How can you participate in this?

Note: This project can be applied to foreign countries or used by teachers outside of North America. As a general rule, it is easier if the area selected is local because information is easier to obtain. As a class project, students might divide into groups, each selecting a species or group of species, such as mammals. This project may be shortened and parts deleted if time is limited, concentrating, for example, on a single species of the region or the general changes in the landscape. It may also be broadened to explore, in detail, the plants and animals of the region by contacting the Natural Heritage Program of your state in the Wildlife Department.

Sources

"Epitaphs for North America's Lost Species and Environments" in Chapter 1 of this book has extensive references listed. Also the fiGrasslands, Shrublands and Deserts,fl fiAquatic Ecosystemsfl and fiForestsfl chapters provide details on these ecosystems and changes in them since settlement. See the fiPersecution and Huntingfl chapter for the treatment of native predators and the effect of their disappearance on ecological systems.

Books and Publications

The following list contains many out-of-print books that may be difficult to obtain, as well as many in-print editions, covering a wide variety of habitats and species of plants and animals. Conduct searches for these and other books in your library and through the Internet.

Ambrose, Stephen E. 1996. *Undaunted Courage. Meriwether Lewis, Thomas Jefferson, and the Opening of the American West*. A Touchstone Book, Simon & Schuster, New York.

Audubon, Maria R. 1897. *Audubon and His Journals*. Vols. I and II. Dover Publications, Inc., New York edition, 1994.

Beard, Daniel. 1942. *Fading Trails. The Story of Endangered American Wildlife*. Macmillan Co., New York.

Blaugrund, Annette and Theodore E. Stebbins, Jr. (eds.). 1993. *John James Audubon. The Watercolors for the Birds of America*. Villard Books, Random House/New York Historical Society, New York.

Brower, Kenneth. 1990. *Yosemite. An American Treasure*. National Geographic Society, Washington, DC.

Chadwick, Douglas. 1990. *The Kingdom. Wildlife in North America*. Sierra Club Books, San Francisco, CA.

Cokinos, C. 2000. *Hope is the Thing with Feathers. A Personal Chronicle of Vanished Birds.* Warner Books, New York.

Davidson, Art. 1989. *Alakshak. The Great Country*. Sierra Club Books, San Francisco, CA.

Devall, Bill (ed.). 1993. *Clearcut. The Tragedy of Industrial Forestry*. Sierra Club Books/Earth Island Press, San Francisco, CA.

DiSilvestro, Roger L. 1989. *The Endangered Kingdom. The Struggle to Save America's Wildlife*. Wiley Science Editions, John Wiley & Son, New York.

Douglas, William O. 1968. *My Wilderness, The Pacific West*. Pyramid Books, Salem, MA.

Dunlap, Thomas R. 1988. *Saving America's Wildlife*. Princeton University Press, Princeton, NJ.

Feduccia, Alan (ed.). 1985. *Catesby's Birds of Colonial America*. University of North Carolina Press, Chapel Hill, NC; London, UK.

Fisher, Ron. 1984. *Our Threatened Inheritance. Natural Treasures of the United States*. National Geographic Society, Washington, DC.

Forbush, Edward Howe and John Bichard May. 1959. *A Natural History of American Birds of Eastern and Central North America*. Bramhall House, New York.

Frome, Michael. 1974. *Battle for the Wilderness*. Praeger Publishers, New York.

Fuller, Errol. 2001. *Extinct Birds*. Cornell University Press, Ithaca, NY.

Geist, Valerius. 1996. *Buffalo Nation. History and Legend of the North American Bison*. Voyageur Press, Stillwater, MN.

Gleason, Herbert W. 1971. *Thoreau's Cape Cod*. Barre Publishers, Barre, MA.

Goudie, Andrew. 1982. *The Human Impact. Man's Role in Environmental Change*. MIT Press, Cambridge, MA.

Grey Owl (Wa-Sha-Quon-Asin). 1937. *Tales of an Empty Cabin*. Dodd, Mead & Co., New York.
Grove, Noel 1992. *Preserving Eden. The Nature Conservancy*. Harry N. Abrams Inc., New York.
Gunter, A.Y. 1972. *The Big Thicket. A Challenge for Conservation*. Chatham Press Inc., Riverside, CT.
Hanley, Wayne. 1977. *Natural History in America. From Mark Catesby to Rachel Carson*. Quadrangle/New York Times Books, New York.
Hawke, David (ed.). 1970. *Captain John Smith's History of Virginia. A Selection*. Bobbs-Merrill Educational Publishing, Indianapolis, IN.
Haynes, Bessie Doak and Edgar Haynes (eds.). 1979. *The Grizzly Bear. Portraits from Life*. University of Oklahoma Press, Norman, OK.
Highwater, J. 1995. *Native Land*. Barnes & Noble, New York.
Hornaday, William T. 1913. *Our Vanishing Wild Life*. New York Zoological Society, New York.
Josselyn, John. 1972. *New-England Rarities Discovered* (reprint of 1672 book), Massachusetts Historical Society.
Kopper, Philip. 1991. *The Wild Edge. Life and Lore of the Great Atlantic Beaches*. 2nd edition. The Globe Pequot Press, Chester, CT.
Kricher, John C. 1988. *Ecology of Eastern Forests*. Peterson Field Guides. Houghton Mifflin Co., Boston, MA.
Laycock, George. 1990. *The Hunters and the Hunted. The Pursuit of Game in America from Indian Times to the Present*. An Outdoor Life Book, Meredith Press, New York.
Madson, John. 1993. *Tallgrass Prairie*. A Nature Conservancy Book, Falcon Press, Helena, MT.
McMillan, Ian. 1968. *Man and the California Condor*. E.P. Dutton & Co., Inc., New York.
Middleton, David. 1992. *Ancient Forests. A Celebration of North America's Old-growth Wilderness*. Chronicle Books, San Francisco, CA.
Mowat, Farley. 1986. *Sea of Slaughter*. Atlantic Monthly Press and Bantam Books, New York.
Peck, Robert McCracken. 1990. *Land of the Eagle. A Natural History of North America*. Summit Books, New York. (See Selected Bibliography in this book, page 282.)
Ponting, Clive. 1991. *A Green History of the World. The Environment and the Collapse of Great Civilizations*. Penguin Books, New York.
Schorger, A.W. 1955. The Passenger Pigeon. Its Natural History and Extinction. University of Oklahoma Press, Norman, OK.
Seton, Ernest Thompson. 1899. *Wild Animals I Have Known*. 1966 edition, Grosset & Dunlap, New York.
Seton, Ernest Thompson. 1911. *The Arctic Prairies*. 1981 edition, Harper & Row, New York.
Teal, John and Mildred Teal. 1969. *Life and Death of the Salt Marsh*. Audubon/ Ballantine Book, New York.
Thomas, Bill. 1976. *The Swamp*. W.W. Norton & Co., New York.
Thoreau, Henry David. *Walden or Life in the Woods* (many editions).
Van Doren, Mark (ed.). 1955. *Travels of William Bartram*. Dover Publications, New York.

Forests

Project Summary

This project involves learning about the types of forests that grow on Earth and selecting one type of forest to describe in detail in terms of the climate, what types of trees grow there and what species of native plants and animals are threatened. It also involves learning about the ways in which this type of forest is being conserved or destroyed.

Background

As described in the Forests and Madagascar and Other Islands chapters, forests harbor the largest number of endangered species of all habitats. Uncontrolled logging, especially of old-growth forests, has threatened the survival of thousands of native plants and animals. Forests are a crucial factor in maintaining the planet's oxygen supply and supplying moisture to the atmosphere. By absorbing vast amounts of carbon dioxide, forests reduce pollution and global warming. Their roots also anchor soils, preventing erosion, and store moisture that gradually seeps into rivers and streams so that they flow year-round, even in droughts.

The world land area covered by forests has been retreating for centuries. Although there are still extensive boreal forests in northern Canada and Siberia, and tropical forest still covers most of the Amazon, forests are being logged at a fast pace. The increase in human populations has resulted in growing numbers of people cutting forests for firewood or to clear land for agriculture. In many parts of the world, forests with extraordinary diversity of life have been nearly eliminated or are in the process of being destroyed. Central Africa's ancient rainforests are being logged for the largest trees, hundreds of years old, and their wildlife, including endangered chimpanzees and Gorillas, is being slaughtered to sell in bushmeat markets. Tropical rainforests, especially those growing in lowland areas, are the most threatened type of forest. These forests harbor the largest diversity of wildlife and plants and are, therefore, most in need of protection. In the United States, entire forest ecosystems have become endangered, and many species of native trees have become threatened, some from diseases of foreign origin, others from logging and development. Examples of threatened forest ecosystems in North America are the native pine forests of the Southeastern United States, the old-growth temperate rainforests of the Northwest and the old-growth forests of the East.

Many species of trees, including the stately American Elm and the American Chestnut, have been decimated by exotic species of fungi. These trees once numbered in the billions. The American Elm has declined and disappeared from many parts of the East, and the American Chestnut is almost extinct throughout its range in eastern North America. It once made up a large portion of the eastern hardwood forests. The wildlife of these forests has lost much of its diversity, as the Gray Wolf, Red Wolf, Mountain Lion, and their prey, the Elk, Eastern Bison and, in northern woods, the Caribou were all hunted to the last animal. Rainforests of the Pacific Northwest, with their towering American Redwoods and Sequoias, Western Hemlock, Red Cedar and other conifers, have been reduced to about 5 to 10 percent of their original range as a result of logging and development. Their wildlife, likewise, is under siege, and many species, including the Grizzly Bear, Fisher, Lynx, Gray Wolf, Northern Spotted Owl and Marbled Murrelet, are absent or extremely rare.

Endangered trees and wildlife of temperate forests in South America include the massive Chilean Larch or Alerce, which can grow for 4,000 years and reach sizes almost as great as the Sequoias of California, the world's most massive trees. Alerces have been decimated, cut for their valuable wood, along with other trees in these forests--species which grew on Earth prior to the appearance of dinosaurs. Vast forests of beeches, for example, and primitive conifers covered millions of square miles in Chile and Argentina, but only a fraction remain, the rest logged to make way for agriculture and livestock. The wildlife of these forests, from the world's smallest deer, the Pudu, to the Andean Bear, is threatened. Likewise, the temperate rainforests of New Zealand and eastern Australia have been greatly reduced, threatening kiwis of several species and other unique wildlife.

Tropical forests of many types, from lowland rainforests to dry deciduous forests and, in higher elevations, montane cloud forests, grow in a belt around the Earth's tropical latitudes. They teem with millions of species of insects, birds, mammals, reptiles and amphibians. The last 5 percent of Brazil's Atlantic coastal forest harbors South America's greatest primate diversity, with species ranging in size from tiny lion marmosets, weighing only a few ounces, to the Muriqui, or Woolly Spider Monkey, the continent's largest primate. All are now threatened with extinction. Madagascar's tropical forests echo with the calls of 33 species of lemurs, charming and fascinating primates that exist nowhere else but in these forests that are being cut for farm plots and charcoal. In Amazonian and Indonesian rainforests, literally hundreds of kinds of colorful parrots fly in noisy flocks, each with its own ecological niche of food type and habitat. Almost one-third of all parrots are now threatened.

A large percentage of tropical forests have been destroyed over the past century, with some areas, such as the Philippines, Thailand, West Africa, Andean countries, the Caribbean and, most recently, parts of Indonesia, experiencing almost total deforestation. The losses here have been dramatic, as Orangutans, Tigers, rare birds and two species of primitive rhinos add to these countries' endangered lists. The countries with the largest numbers of endangered birds, Indonesia and Brazil, have lost, or are in the process of losing, large tracts of tropical rainforest. Entire ecosystems are collapsing in the process. The great variety of fig trees of Southeast Asia depend on hornbills to distribute their seeds, but these birds are fast disappearing. Pollinating species like bats, small primates and birds are also in sharp decline as the rainforests are destroyed. Many are found only in a limited area, surviving in the remnants of these forests.

On the positive side, many large preserves have been set aside in South America to protect this diversity, and conservationists are working in other parts of the world to protect parks and help establish new reserves to prevent massive extinctions in these forests. Paper recycling and using substitutes for wood-based products are also conserving trees.

Activities

o Examine as many of the books listed below, showing the great beauty and diversity of forests, as possible. These include *Jungles; The Rainforests*, *A Celebration; The Life and Mysteries of the Jungle*; *The Living Wild; Hotspots. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*; *North America's Rainforest. The Endangered Paradise*; *Living Planet. Preserving Edens of the Earth*; *Ancient Forests. A Celebration of North America's Old-growth Wilderness*; and *The Enchanted Canopy*. *A Journey of Discovery to the Last Unexplored Frontier, the Roof of the World's Rainforests*. Also, read books on particular forest species, such as butterflies, birds, primates, bats or insects. Many are listed in the Books and Publications section. See films listed below and in the Video section of this book on forests, particularly threatened ones in Madagascar and other parts of the world, as well as films of endangered forest wildlife. This introduction is intended to create enthusiasm and curiosity as well as an appreciation of the wealth of plants and animals that are at stake as old-growth forests are destroyed.

o Select a forest from the list below to study its status and threatened trees and wildlife.
- United States southeastern Long-leaf Pine forests
- North American eastern hardwood forests
- North American temperate rainforests
- South American temperate rainforests
- Brazilian forests of Atlantic coast
- New Zealand or Australian temperate rainforests
- Madagascar tropical rainforest
- Hawaiian tropical rainforest
- Mascarene tropical forests
- West African tropical rainforests
- Andean tropical rainforests and cloud forests
- Central American cloud forests

- Colombian rainforests
- Caribbean tropical forests
- East African tropical forests
- Indonesian rainforests
- Philippine rainforests
- Indian montane forests of the Ghat region
- Himalayan forests
- Chinese tropical forests

o Read about this type of forest in *The Endangered Species Handbook* and in references listed in the Forests chapter and the Books and Publications section. Also consult the Internet.

o Describe the original extent of this forest several hundred years ago, and the present extent. (Collins 1990 and Mittermeier 1999a, cited below, are excellent references.) Explain how it has become threatened. For example, some forests have been gradually whittled away by cutting for firewood or land clearance, while others have been cut by corporate logging companies or government programs to establish large-scale agricultural farms. Still others have been officially conserved but, through failures in enforcement or misguided policies, their wildlife and trees have been lost.

o What species of wildlife and plants or trees have become endangered as a result of the destruction of these forests? Which species are unique to that forest region? Describe them.

o Select an animal or plant species that is threatened with extinction and write a short report about it, using the criteria in the project, "Profile of an Endangered Species." It can be a type of butterfly, orchid, ant, bird or mammal, for example. Write about the species in the context of its forest habitat, whether its habitat is being protected, and other threats to it that may include pollution, trade or competition with exotic species. As source material, consult this book, *Threatened Birds of the World, Walker's Mammals of the World*, and other references cited here or in the Books and Publications section of this book.

o By consulting books, such as *Hotspots* and other books listed below, list the threats to the forest you are describing and what is being done to protect the forest and its wildlife.

o Read the Forests chapter for information on the use of plants, such as kenaf, to make paper and building houses with little or no lumber. Discuss the role these measures could have in conserving forests. Write organizations, such as Earth Island Institute, for information.

Books and Publications
Films

Forests: Books and Publications

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Forests: Films
The films below are reviewed in the Video section, which gives information on their distributors and more detail on their content. Also, films on individual forest species, such as Tigers, are reviewed, along with additional films on many of the subjects and regions above.

General films on rainforests: "Rain Forest" and "Exploring the High Frontier," both by National Geographic Society.
Temperate rainforests in US: "Ancient Forests,fl fiLast Stands of the Giants"
Temperate pine forest of US southeast: "Remnants of a Forest"
US National Forests: "Our Vanishing Forests"
Regional: "Amazonia: A Burning Question;" "The Decade of Destruction" (Amazon rainforest); "Korup--An African Rain Forest" (Cameroon); "Spirits of the Forest" (Madagascar); "Forest Primeval" (Part 3 of "Heart of Africa") (Democratic Republic of the Congo & area); "Animalai, India's Elephant Mountain" about the Indian Ghats; "Monkeys on the Edge" (Brazil's Atlantic forest); "Song of Protest," "Land of the Kiwi," and "Mountains of Water" (New Zealand).

Grasslands
Project Summary
The purpose of this project is to learn about the wild grasslands of the world, their wildlife and threats to them. One particular region will be selected and its original extent, wildlife, and present status will be described. The ways in which this grassland is being conserved or destroyed will be a major focus.

Background
Just a century ago, grasslands covered much of central North America, from southern Canada through Texas to northern Mexico, and from west of the Rockies east to Midwestern and northeastern states. Tall-grass prairie, with grasses up to 12 feet in height, grew from Ohio west to the Mississippi River area. This savannah grassland had groves of oak and other trees. It had extremely rich soil and was plowed by American settlers into farmland. Today, less than 1 percent of the original extent remains, making it an extremely endangered natural ecosystem. West of the tall-grass prairies, a mixture of tallgrass and short-grass prairies existed, and further west, short-grass dominated. The short-grass and mixed prairies have also been plowed for crops, but some sizeable areas remain, primarily kept as pasture for cows. These grasslands have been greatly altered, leaving few examples of the original ecosystems. Vast herds of American Bison once grazed throughout these grasslands, with prairie dog towns covering millions of acres in the short-grass prairies.

The savannahs of East Africa, grazed by a great diversity of hoofed animals, represent a classic example of grasslands that are still in natural, intact condition. Although under stress from growing human populations, large reserves and national parks protect much of this region. By contrast, the dryer grasslands of southern Africa have been severely damaged by the introduction of large numbers of domestic cattle and the fencing off of wildlife from waterholes and prime grasslands to prevent the spread of hoof-and-mouth disease to cattle. This has resulted in a large decline in overall numbers of both herbivores and carnivores. This is a repetition of the overuse of the Sahara and Sahel regions

to the north, centuries before, by great herds of domestic camels and sheep, turning grasslands into sandy desert. Ethiopia, Somalia and countries to the north and east of the Serengeti in East Africa's horn were once covered in lush grasslands. Wildlife species found only in this region became threatened when Europeans introduced livestock, which infected wild ungulates with rinderpest and other diseases, causing massive mortalities.

In vast steppes that once stretched from the Black Sea to western China, livestock now far outnumber native ungulates, such as the Saiga antelope, a species that once thundered in herds of millions. Overgrazing and plowing of this dry land for crops has further degraded it, causing massive dust storms, similar to those that resulted from plowing the American prairie in the 20th century. South America has extensive grasslands in Venezuela and south-central Brazil, many of which become wetlands during rainy seasons. In Argentina and Chile's Patagonian grasslands, rheas, deer, Guanacos and other wildlife once abounded. After centuries of overgrazing by sheep and cattle, this wildlife has declined greatly, and the grasslands are turning to desert. Australia's grasslands have also been converted to use by livestock, displacing the varied marsupials and rodents that once thrived here.

Preservation of grasslands and their wildlife is now taking place in many parts of the world, including the United States, southern Africa and Australia. Reserves of remnant grasslands, with their great diversity of wildflowers, grasses and other plants, are being set aside and native wildlife reintroduced. This trend may spread to parts of Asia as well, but the pressures of human populations requiring farmland and grazing for livestock may prevent restoration in most areas.

Activities

o Read "Epitaph for America's Lost Species and Environments" in Chapter 1 to learn about the travels of Lewis and Clark through these prairies early in the 19th century, followed by the extermination of the great herds of bison, deer and Pronghorn. Read the Grasslands, Shrublands and Deserts chapter with references cited for more information on North American and other grasslands around the world and their endangered species. Write a short paper describing the changes in grasslands in North America since colonial times and the effects on wildlife.

o Select a grassland from the following list to study its wildlife and present status:

- North America's Tallgrass Prairie
- North America's Short-grass Prairie
- Central Asia's Steppes
- Australia's Grasslands and Drylands
- Saharan and Sahel Drylands
- East Africa's Serengeti
- Southern Africa's Grasslands
- Horn of Africa's Grasslands
- South America's Pampas
- South America's Patagonia

* What species of wildlife, plants or trees have become endangered as a result of the destruction of this region's grasslands or affected by related activities, such as grazing and meat hunting, by herdspeople? Which species are unique to that grassland region? Describe them.

* Select an animal or plant species native to this region that is threatened with extinction, and write a short report about it, using the criteria in the project, "Profile of an Endangered Species." It can be a type of wildflower, tortoise, butterfly, bird or mammal, for example. Write about the species in the context of its grassland habitat, whether its habitat is being protected, and other threats to it that may include pollution, trade or competition with exotic species. As source material, consult this book, *Threatened Birds of the World, Walker's Mammals of the World*, and other references cited here or in the Books and Publications section of this book.

* By consulting books such as those listed below, describe the threats to the particular grassland or dryland you have selected, and discuss what is being done to protect the natural habitat and its wildlife?

o Use this project as a model to study the status of shrublands and deserts, as described in the Grasslands, Shrublands and Desert chapter of this book, with the emphasis on desertification of drylands into desert through grazing, firewood gathering and other activities. See the reference list of the latter chapter for further reading.

o If you live within the range of these habitats, participate in a project to restore native plants to a grassland. Grassland birds have undergone drastic declines in the past decade, mainly through loss of habitat. Identify the grassland birds in your area and help in a project to obtain habitat for them, improve existing habitat or grow seeds of native plants for planting. Several source books supply information on mail-order nurseries that sell native plants and seeds. *Noah's Garden* has chapters entitled, "In Respect of Grass" and "To Plant A Prairie," which give very specific information about these habitats. The National Wildflower Research Center (2600 FM 973 North, Austin, TX 78725) supplies native plant bibliographies for each region and lists native plant associations. A book written by Lady Bird Johnson, who founded this center, and Carlton B. Lees, *Wildflowers Across America*, is a dazzling showcase of native wildflowers as well as an excellent source of information on these ecosystems. If you live near a shrubland or desert, plant native flowers and plants in your garden instead of grass to restore the ecosystem and conserve water. See the list of books below for instructions on planting desert and dryland gardens.

o If you live in an area where grasslands are mowed for hay, begin a public relations campaign to convince farmers to wait until after bird nesting season is over to mow. This would be in late July or August for most species of grassland birds. Consult reference books to determine the nesting times of grassland birds in your area. Such measures would be of great help to certain birds that have lost most of their natural grassland habitat. Make up posters that illustrate one or more of the following birds, and text describing their decline and need for undisturbed nesting habitat. In the East, the Bobolink, Grasshopper and Henslow's Sparrows and Bluebird, among others, will benefit. In the West, various species of Lesser and Greater Prairie Chicken, Sage Grouse and other bird species mentioned in the Grasslands, Shrublands and Deserts chapter are among these. Ask farmers and landowners to help preserve these birds and other wildlife by mowing practices. Have signs made that landowners could post on their property saying, for example, "Grassland Birds Protected Here." Publicize the campaign through letters to the local newspapers and speeches at local organizational meetings.

o Construct nesting boxes for Bluebirds and Purple Martins to be donated to landowners in grassland with scattered trees or bordered by woods. Instructions on how to make and maintain Bluebird houses can be obtained from the North America Bluebird Society, P.O. Box 6295, Silver Spring, MD 20906. *The Complete Birdhouse Book*, by Don and Lillian Stokes, also gives instructions on building and upkeep for both the Bluebird and Purple Martin houses. Films made by Don and Lillian Stokes include advice on planting for birds by species, such as hummingbirds and grassland birds; advice on how to construct, place and maintain bird nesting boxes is also given (CPTV Offer, P.O. Box 82, Hopkinton, MA 01748). The placement and maintenance of bird nest boxes should be long-term so that they may provide permanent nesting homes. It is important to keep records on the occupancy and breeding success of each box.

o Help native butterflies by planting wildflowers of species that are needed for their life cycle. The Monarch Butterfly, for example, requires Milkweed plants for feeding and laying its eggs. Learn about the species of butterflies and other pollinating insects in grasslands in your area, especially those in decline. For species listed on the US Endangered Species Act, all conservation projects should be coordinated with the US Fish and Wildlife Service and your state Natural Heritage Program (affiliated with the Department of Game or Wildlife in each state). Roadsides next to highways or in median strips and along country roads or railroads provide important habitat for butterflies, especially in areas where grasslands are disappearing. Contact your state and local transportation departments to obtain permission to plant wildflowers in these areas. The North American Butterfly Association (909 Birch St., Baraboo, WI 53913) provides information about helping butterfly habitat and butterfly watching, a new and fascinating activity for which there are guide books. *A World for Butterflies. Their Lives, Behavior and Future*, by

Phil Schappert, is a primary source of information about butterfly life histories, habitats, conservation and threats. It also contains beautiful photography of hundreds of butterfly species worldwide. More information can be obtained from Dr. Schappert via the Internet: www.aworldforbutterflies.com. *Butterfly Gardening: Creating Summer Magic in Your Garden*, published by the Sierra Club, was compiled by the Xerces Society, a conservation organization for native American butterflies, in cooperation with the Smithsonian Institution. Be careful not to use commercial wildflower seed mixes that include species not native to your area or even to the United States. Certain exotic wildflowers, such as Purple Loosestrife, a European plant, are spreading in the United States, drying up marshes and crowding out native wildflowers.

Books and Publications
Films

Grasslands: Books and Publications

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The Complete Birdhouse Book
The Bluebird Book
The Bird Feeder Book.
Little Brown & Co., New York.

Grasslands: Films

All films mentioned below are reviewed in the Video section.

"Crane River" is a celebration of the huge flocks of Sandhill Cranes that migrate across North American prairies.
"Durrell in Russia" is a 12-part series which includes films on the Saiga, European Bison and grasslands of Russia.
"Emas. High Plain of Brazil" centers on this large grassland, surrounded almost entirely by agriculture that serves as an island for Brazil's unique grassland animals, including the Giant Anteater and Maned Wolf.
"Grasslands," a Canadian Broadcasting Company documentary, describes the biodiversity and ecology of North American grasslands and their destruction.
"Land of the Eagle," a series, concerns North America as it was prior to settlement by Europeans, with segments on the prairies and their wildlife.

"Mysterious Black-footed Ferret" focuses on this extraordinary and highly endangered prairie native, filming its graceful, sinuous movements and rapid leaps while hunting prairie dogs.
"Nature of Australia" explores the natural history of the continent in six parts, from its grasslands to drylands, how native wildlife has been affected and what ecological harm has been done by humans.
"The Saiga of Kazakhstan" chronicles the decline in the herds that numbered more than 1 million animals as a result of hunting, fencing off of grasslands and loss of habitat. They have disappeared from the center of their original range in Central Asia.
"Sea of Grass" (segment of "The Living Planet") is one of the parts to this BBC series that describes the evolution of various ecosystems of the Earth.
"The Tiny Carnivores" introduces one to Australia's small marsupials, many of which are nocturnal and endangered, driven from their habitats in grassland, savannah and desert by human activity.
"Vanishing Prairie," a Disney classic, shows the inside of a prairie dog burrow and the wildlife that teems in this habitat.
"Varmints" documents the decline of prairie dogs in the American West through systematic poisoning programs by federal, state and local authorities, placing them in endangered status, and explains their important role in prairie ecosystems.
"Wildebeest Race for Life" follows the trail of 1 million of these odd-looking ungulates as they migrate in a large circle around the Serengeti.

Aquatic Ecosystems

Project Summary

Aquatic ecosystems are the most varied of all ecosystems, ranging from freshwater ponds to rivers, lakes, saltmarshes, coasts, mangroves and coral reefs to open ocean. Although a single type of ecosystem will be chosen for the project, it is hoped that the reports will be presented to the class to acquaint students with the characteristics of as many of these habitats as possible. The project will consist of selecting a particular type of aquatic ecosystem that is threatened in a geographical area listed below. This ecosystem, the threats to it--whether through pollution, damming, diversion or other activity--will be described, including its wildlife. Also certain aquatic species that are in sharp decline will be among the subjects listed for special attention. The ways in which this aquatic ecosystem, species or group of species is being conserved or destroyed will be a major focus.

Background

The aquatic ecosystems of the world have never been more stressed and degraded. The rise in human population to more than 6 billion people by the end of the 20th century placed strains of overuse and pollution on the limited supplies of fresh water, leaving billions of people without adequate clean water supplies and creating rising tensions over water rights. In these conflicts, wildlife pays a high price, losing pristine habitat and becoming contaminated with toxic chemicals and oil spills that are killing wildlife around the world. Dams have endangered numerous fish by impeding their migrations, and developing countries have been damming their rivers at an increasing rate. Rivers that flowed swiftly become still ponds after damming, an alteration to which many fish cannot adjust. Many of these fish are also declining as a result of the introduction of non-native fish, which are out-competing them. The Nile Perch was introduced as a food fish in Lake Victoria, and it has virtually eliminated hundreds of species of native cichlid fish, colorful and ancient species. The Colorado River of the US west has many dams on it, which have totally altered

the river's flow patterns and temperature, endangering many fish that had evolved in the swift-flowing, silt-laden water. The most dramatic example of a dam endangering a wide variety of plants and animals, and dislocating 1 million people, is the Three Gorges Dam being built on the Yangtze River of China. It will almost certainly result in the extinction of the Yangtze River Dolphin, a very ancient freshwater species, the Yangtze Sturgeon and numerous plants that will be inundated by the waters. Although far upstream, it will also have the effect of drying up wetlands downriver and at the delta. With inadequate provision for sewage treatment for the millions of people and industry living alongside the new lake formed by the dam, the Yangtze is expected to become extremely polluted. Large dams inundate vast areas, displacing thousands of people from their homes and drowning rare trees, plants and wildlife.

Diversion of rivers for agriculture or water supply has left many riverbeds and deltas dry, causing entire ecosystems to collapse. An increasing problem with rising temperatures has been violent storms which cause severe flooding of rivers, made worse by the deforestation that robs hillsides and riverbanks of protective trees that absorb rainfall throughout the year and hold the soil in place. Lakes and spring ponds that dry up in the summer are also being filled in by developers and government projects, eliminating habitat for myriad aquatic creatures, from frogs and salamanders to turtles and water birds.

Overfishing, pollution and destruction of ocean environments have reached crisis proportions, with 70 percent of all fish caught commercially in depleted status or worse, including some of the most ecologically important species--sharks, tuna and others at the top of their food chain. Toxic chemical pollution has increased, especially in colder waters, where whales and other cetaceans are dying from massive build-ups of chemicals such as PCBs (Polychlorinated Biphenyls), pesticides, heavy metals and other toxins. Along the pristine coast of Washington state, Killer Whales are dying from these toxic chemicals, as are white Beluga Whales in the St. Lawrence River. A Sperm Whale that died recently of toxic chemicals had to be disposed of as highly toxic waste. Other waste in the oceans is killing wildlife. Abandoned driftnets drown thousands of birds, seals, sea lions and sharks, and fishing line entangles endangered Northern Right Whales and other wildlife, drowning them. Plastic sheeting, balloons, plastic from six-packs and other trash are killing seabirds, such as the long-lived and declining albatross, which unknowingly feed this trash to their chicks, killing them, or swallow the items themselves, later dying of blocked intestines. Collisions with ships and motor boats are causing large numbers of deaths in Florida Manatees and whales.

Coral reefs, the most beautiful and biologically diverse ocean ecosystems, are dying from many threats. Dynamite and cyanide used to kill and capture fish destroy the entire reef. Overfishing, pollution and silt that washes off nearby lands from agriculture and development can combine to kill a reef. Global warming causes coral bleaching that is affecting a growing number of reefs. More than one-third of all coral reefs are now dead or dying.

Wetlands have declined in the United States by 50 percent. This has resulted in more destructive floods and losses in fisheries production. Wetlands filter pollutants, and their reduction has lowered water quality. Elsewhere in the world, similar declines have taken place. Both fresh and saltwater marshes provide important benefits in cleaning water through a natural filtration system. In fact, the worldwide value of this benefit to the Earth and human society has been calculated at $1.7 trillion. Marshes also provide important flood controls by absorbing large amounts of water from nearby sources or rainfall, as well as a multi-billion dollar benefit of serving as nurseries for fish, shellfish and other wildlife. Traditionally, however, they are filled in for development, airports, seaports and other commercial uses which are considered to be far more beneficial to society. It is important to reexamine such an approach, especially in view of the tremendous costs of flooding in human lives and property and the decline in fish and shellfish harvests.

An atmospheric phenomenon caused, apparently, by CFCs, or chlorofluorocarbons, chemicals used in refrigeration and for other industrial purposes, is thinning the ozone layer, a protective shield that filters the sun's rays before they strike Earth. Large holes have developed over the Poles, especially the South Pole, allowing huge amounts of ultraviolet rays from the sun to enter the atmosphere, causing many cases of skin cancer in humans and having unforeseen effects on animals with sensitive skin like frogs and salamanders. Frog species are disappearing at a catastrophic rate, especially those that lay their eggs in the open, exposed to the ultraviolet rays of the sun. Frogs are

also suffering grotesque birth defects, which may be caused by pesticides or virus outbreaks. Frogs™ decline may be a warning sign that serious problems exist in the aquatic ecosystems of the world that will soon begin to affect human beings.

Activities

o Read the Aquatic Ecosystems chapter, which describes many of these problems in detail and parts of the world where large numbers of animals and plants are endangered. The references cited will provide more information.

o Select a species of wildlife or plant that has become endangered as a result of the destruction of aquatic ecosystems or related activities. Describe its status, threats to its habitat and what--if anything--is being done to prevent its extinction.

o Select an aquatic area from the following list to study its wildlife and present status:

- United States™ Colorado River
- Florida's Everglades swamp
- Rivers and wetlands of the US East and Southeast
- Russia's Lake Baikal
- Central Asia's Aral Sea
- East Africa's Lake Victoria
- Southern Africa's Okavango Delta
- Brazil's Pantanal wetlands
- Amazon River and its dams
- China's Yangtze River
- Australia's Great Barrier Reef
- Mississippi River Delta and adjacent waters

All are described in the Aquatic Ecosystems chapter. See also Video and Books and Publications sections.

o The following wildlife has become endangered as a result of the destruction of these aquatic ecosystems or related activities. Select one and discuss threats, species involved and conservation programs:

- albatross and other large seabirds
- frogs
- whales and dolphins
- sharks
- sea turtles
- penguins

o Select an aquatic animal or plant species that is threatened with extinction and write a short report about it, using the criteria in the project, "Profile of an Endangered Species." It can be a type of fish, frog, turtle, aquatic insect (such as a dragonfly), bird or mammal, for example. Write about the species in the context of its aquatic habitat, whether its habitat is being protected, and other threats to it, which may include pollution, trade or competition with exotic species. As source material, consult this book, *Threatened Birds of the World, Walker's Mammals of the World* and other references cited here or in the Books and Publications section of this book.

o Make comparisons between natural means of flood control, including marshes, beaver ponds and heavily forested stream and riversides, and artificial means, such as levees, dikes and canals. *Water, A Natural History*, listed below, is helpful in pointing out the differences. Compare the cost and success of natural means of controlling pollution, such as sewage through marshes that filter waste, and artificial means through sewage plants. Individual homes in

suburban and rural areas use septic tanks and cesspools to store sewage. In times of heavy rain, however, they often overflow into rivers, as do urban sewage plants. In many parts of the world, no sewage treatment exists, causing rivers and waterways near cities to become severely polluted. Some cities in California and elsewhere have constructed artificial marshes to filter sewage water, creating, in the process, wildlife havens. New types of toilets, known as compost toilets, are another less-polluting innovation. Read Chapter 9, "Aqueducts and Toilet Bowls" in *Water, A Natural History*, and write a short report on improvements needed in the present systems.

o Grassroots organizations throughout the world have been successful in restoring rivers and other aquatic ecosystems. Using a book, such as *How to Save a River. A Handbook for Citizen Action*, select a river, wetland, pond (including beaver ponds), lake or vernal pool (temporary wetland that dries up in the summer) to help preserve or clean up from pollution. Small projects can be of importance in conservation. For example, some high school classes in the Midwest sampled a nearby marsh for the types of frogs found there and discovered that the majority were deformed, having five or more legs, misplaced eyes or other grotesque malformations. The situation was given publicity, and research began on the causes. Pesticide contamination was considered the most likely cause, since water from the marsh used to grow frogs in captivity produced similar deformities. One organization, The Riverlands Conservancy, has helped purchase river habitat in Oregon, Missouri and Washington totaling 17,174 acres since 1993. Measuring pollution in local waterways is an excellent class project that can lead to environmental action on the part of state or federal authorities. Save Our Streams program, run by The River Network, headquartered in Portland, Oregon, and its sister organization, The River Clearinghouse, provide information to activists throughout the country on an 800 "hot line," using a database of volunteer experts who provide advice. The River Watch Network has been instrumental in helping communities monitor water quality in order to restore and protect rivers. (See *How to Save a River. A Handbook for Citizen Action* for more information and other organizations, which include American Rivers, the International Rivers Network and Riverkeepers, working to preserve aquatic ecosystems.) Using these examples, propose a class project to help conserve a local aquatic ecosystem**.**

Books and Publications
Films

Aquatic Ecosystems: Books and Publications

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Aquatic Ecosystems: Films

All films mentioned below are reviewed in the Video section.

General: "Acid Rain. Clouds with a Sulphur Lining" discusses the severe problem of acidification of rainwater caused by air pollution and its effect on forests and other environments. "Dead Ahead: The Exxon Valdez Disaster" is an examination of the 1989 oil spill in Alaska from many aspects. "Pollution: World at Risk" is a general look at various types of pollution and toxic chemicals and their environmental effects. "Vanishing Wetlands," produced by the Canadian Broadcasting Company, explains the ecological benefits of wetlands and threats to them. "The Wasting of a Wetland" focuses on the Everglades but describes the abuse of wetlands as it affects wildlife**.**

Ocean environments: "Cities of Coral"; "Coral Reefs. Rainforests of the Sea"; and "Jewels of the Caribbean Sea" all center on coral reefs. They show the great beauty and diversity as well as the threats to them. "Creatures of the Mangroves" and "Margins of the Land" (segment of "The Living Planet") treat the shoreline areas, and "Messages from the Birds" concerns the decline in shorebirds in North America. "The Open Ocean" (segment in "The Living Planet") explores the evolution of this habitat on Earth. "The Mirage of the Sea" discusses the overfishing and exploitation based on the assumption that there would always be plenty of fish. "Blue Whale: Largest Animal on Earth" is the first film to follow these giants in the ocean. "Desert Whales" are the Gray Whales that winter off Baja California, Mexico. "The Forgotten Mermaids" is a film about Florida Manatees. "Sperm Whales: The Real Moby Dick" gives glimpses into these deep-diving whales and discusses the fact that they have not recovered from whaling, with large males still very rare. "Colony Z" is about the very rare Yellow-eyed Penguin of the New Zealand region. "Whales Down Under" focuses on a population of newly discovered Southern Right Whales east of New Zealand, following them for a long period.

Freshwater environments: "Sweet Fresh Water" (segment in "The Living Planet") is an in-depth look at the planet's limited supply of water and the creatures who inhabit these environments. "Giant Otters" follows a boisterous group of these largest of otters in South America, discussing the causes for their decline. "Journey to Save a Crane" describes a project of the International Crane Foundation to preserve the endangered Siberian Crane through delicate negotiations with Chinese and Russian authorities. "White Water, Blue Duck" is a film about this threatened New Zealand duck and its remarkable adaptation to a very swift-flowing river. "Jewel of the Rift" (segment in "Heart of Africa" series) concerns Lake Victoria, its geology and the amazing, colorful fish native to it, which are now being eliminated by the Nile Perch. "Okavango: Jewel of the Kalahari" explores this huge wetland, second largest in Africa, set in the middle of a desert. "Amazon. Land of the Flooded Forest" illustrates how the flooding of the Amazon River each year nourishes a diverse ecosystem of fish, freshwater dolphins, fruits and trees. "Journey to the Sacred Sea" travels to Lake Baikal, where the unique fish and seals inhabit an extremely ancient and deep lake threatened by pollution. "Cadillac Desert" is an expose of the diversion of lakes and rivers to supply Los Angeles with its water supply at the expense of wildlife and the environment. "Prairie Waters" visits the potholes of Midwestern North America, temporary ponds and lakes that provide breeding habitat for millions of ducks and other birds each spring, yet are routinely filled in by farmers. "The Wild Colorado" is a thorough look at the geology and ecology of the Colorado River and the effect of dams on its wildlife and ecology.

Trade

Project Summary

To better understand the international wildlife trade in live animals and animal products, focus will be placed on one or more major categories of the trade. The major categories are: whaling, fur, reptile skins, Traditional Medicine products, fisheries, wild pets (including cage birds, lizards, turtles, snakes and frogs). Selection by a student of a species, group of species or general subject under one of these categories allows an overview that can be thorough and involve much research, or result in a short report. A classroom project could involve a subject such as Traditional Medicine, in which groups of students would select individual species or groups of species, such as rhinos (killed for their horns), Tigers (killed for every part of their bodies), seahorses, snakes, turtles, monkeys and other primates and sharks. The reports would be presented together.

Background

Trade in live animals, plants and the products made from them has caused extinctions and has pushed many to the edge of extinction. At least 15 percent of highly threatened mammals and birds have declined as a result of trade, according to the International Union for the Conservation of Nature and Natural Resources (IUCN) (see Hilton-Taylor 2000). Internationally, billions of dollars are earned legally and illegally, and each year, more species become exploited. The trade is second only to the international drug trade in overall profits, worth an estimated $3 billion a year in protected live animals and animal products. As soon as one species becomes rare from exploitation and receives protection, the trade switches to a similar one, pushing it into threatened status. Much of this trade is for luxury products or to supply collectors and the wealthy who wish to own rare birds and other wildlife; wear the furs of endangered species, such as Snow Leopards or Cheetahs; purchase purses or clothes made from rare snakes or other reptiles; or consume luxury foods, such as endangered fish, whale and even Tiger meat. The wool of the Tibetan Antelope, the Chiru, ivory from elephants, the caviar of the endangered Beluga Sturgeon, rhinoceros horn and live Spix's Macaws, captured for collectors of rare animals, are worth far more than gold. The Traditional Medicine trade deals in a wide variety of animal products and plants and is a major factor pushing the Tiger, rhinoceros, seahorses and a host of other species toward extinction. For the majority of species exploited for this trade, substitutes exist or the products are not effective remedies. Ecological systems worldwide are being disrupted with the removal of predators and other keystone species, causing a loss of biodiversity.

This trade is taking place in spite of the landmark Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), enacted in the 1970s and now ratified by a majority of the countries in the world. It places animals at greatest risk of extinction on Appendix I, which prohibits commercial trade, and threatened species on Appendix II, which limits or controls trade on a species-by-species basis. CITES bans trade in species listed on either Appendix if the trade will be detrimental to the species' wild populations. In practice, many species that are threatened with extinction and listed on CITES Appendices are traded illegally or in countries which lack national legislation restricting wildlife trade. Although endangered spotted cat fur coats are no longer seen in New York City clothing stores, the fur trade continues to use the skins of rare cats and other wildlife, which are openly sold in many countries around the world. Enforcement funding is inadequate in the majority of countries, even the United States, where only 10 percent of shipments are inspected. Moreover, certain products, such as powdered rhino horn or Tiger bones, can be easily secreted in packaging while in transit. CITES has been an important deterrent to trade in endangered species, however, providing many threatened animals and plants with needed protection. Also, a growing number of countries have strict legislation prohibiting trade in protected species, including exports.

The methods used to capture and kill animals for the wildlife trade are often cruel in the extreme. Steel-jaw leghold traps and wire neck snares that cause great pain and injury produce pelts for the fur and bushmeat trades. Whales die from exploding harpoons thrust into their heads and bodies. Frightened live animals are crowded into cramped, dirty cages and transported to pet shops and laboratories, suffering high mortality along the way. Man's inhumanity to animals reaches an extreme in the wild animal trade.

Activities

o Read the Trade chapter in this book and other sources referenced.

o Select a subject among the following wildlife and plant trades for further study:
- fur trade
- whaling and sale of whale meat
- sea turtles--trade in eggs, meat, shell and stuffed curios
- fine wools--Shahtoosh from Tibetan Antelope and Vicuña
- bushmeat from endangered gorillas, chimpanzees, monkeys, turtles and other wildlife of Africa and Southeast Asia
- fisheries products--sharks for their fins and meat and caviar,

for example
- reptile products for luggage, handbags and other luxury goods
- wild bird pets
- reptile pets, such as lizards, snakes and turtles
- fish for aquariums
- butterflies for collectors
- plants, such as orchids and cacti, for collectors

After reading about these trades in this book and other sources, write a report that discusses the following aspects:
- How many animals or plants are estimated taken per year for this trade?
- What species are they? What is their status in the wild?
- Where are the animals and animal products sold? Are they killed or collected in one country where they are protected and then sold in another?
- What controls exist to protect threatened and endangered species traded? Are they listed on CITES or the US Endangered Species List? Are they protected in their country of origin with high penalties for illegal take or killing, or are the penalties so low that there is an incentive to capture the species illegally? In India, for example, wildlife smugglers and killers of Tigers and other protected wildlife almost never receive jail sentences or large fines, while in China, the death penalty can result from killing a Giant Panda.
- What profits can be earned from sale of these animals or animal products? Find out the prices of expensive goods, such as Beluga or other Russian caviar, Shahtoosh and other items.
- What are the potential ecological effects of the disappearance of these animals? African and Asian Elephants are keystone species, distributing tree seeds, creating water holes and forest openings that benefit their ecosystems. Their disappearance from many areas has already had ecological effects. Find other examples, such as Tigers, which are at the top of their food chain; monkeys and other primates who pollinate flowers or distribute seeds; birds caught for zoos and collectors, such as hornbills, who distribute fig seeds; or animals that are important food items for wildlife.

o Traditional Medicine trade--a group project. Based on the information in the Trade chapter and the references below, divide the class into groups and have each group select from the various species used in this trade, such as Tigers and other wild cats, rhinoceros, monkeys, seahorses, musk and other types of deer, snakes, pangolins, bears of all species and rare plants. The information for each group to gather is the following:

- What is the extent of this trade? Are animals and plants being collected throughout the world to supply the trade?
- What percentage is sold in China, other parts of Asia or in Asian pharmacies in other parts of the world?
- What prices are obtained for these animals at the level of the captor, the local markets, exporter, importer and retail sales?

What effect is this having on the species? Will it become extinct if the trade continues at its present level?
- Is the trade legal in the animal's country of origin? Is the species listed on CITES or banned from importation or exportation? Is the species openly sold in some markets? Where and when?
- Are there education programs that are trying to stop the killing, marketing and purchase of these species or the over-harvesting of rare plants? What governments or organizations are trying to help these species through protection of habitat, bans on commerce or enactment of strong legislation to protect them?

o Enforcement of existing legislation is crucial to protecting threatened and endangered animals and plants. What state and federal laws ban the sale, killing and purchase of endangered species? How is evidence gathered for wildlife crime cases? How does CITES work?

o Visit stores that sell animal products and live animals.
- Fur and department stores with furs: List the kinds of animals used to make the garments being sold. It is required by US law that the species of animal and country of origin be listed on the label. List the ranched animals, such as mink and chinchilla, and wild-trapped ones, such as lynx, beaver and raccoon. Write down the number of coats and other garments of each type of animal, the date, the store and its address. Neither ranched nor wild animals are humanely treated prior to their deaths. Learn about the methods of killing of wild animals (types of traps, number of animals killed per country and US state) and the numbers and species of animals farmed. Contact the Animal Welfare Institute, the Humane Society of the United States and PETA for films that show the cruelty of trapping. Farmed animals are kept in tiny cages, where they become neurotic, and killing methods are unregulated.

- Visit department and shoe stores to determine whether reptile products are being sold. This trade kills millions of animals and threatens many species, as well as causing rats and other rodents they prey on to increase to pest proportions when too many snakes and other reptile predators are killed. List the species from which the item is made, if possible. Laws regarding labeling of reptile products are less strict than those regarding furs, and some do not list the species. If possible, determine if any endangered species are sold and how many items are being sold in your area.

- Visit pet stores to inventory reptile pets, such as iguanas, lizards, snakes and turtles. Find out how many are wild-caught, what species and whether threatened. Also visit pet stores to inventory their cage birds. Ask if the birds were taken from the wild or are captive-bred. In the United States, wild-caught parrot imports are allowed only for a few breeders, and parrots in pet stores should be captive-bred. Ask if the birds were bred in captivity. Many finches and other birds are also banned from importation. Obtain a copy of the Wild Bird Conservation Act and see if any of the species listed as fibannedfl are being sold. If so, tell the store owner and report this to the US Fish and Wildlife Service Law Enforcement Division. Contact the Environmental Investigation Agency (EIA)

for films that show the capture of wild birds in Senegal and Argentina and the cruelty involved in the cage bird trade. If any pet store is selling primates, find out the species. It may be endangered, as in the case of a Diana Monkey sold in a Long Island pet store a few years ago. Primates do not make good pets and should not be purchased. Many organizations receive unwanted primate pets to care for, after they have bitten their owners. Ask your local pet store to avoid sale of live animals. This is a trend in many pet stores that now sell only pet food, leashes, books and other non-living items. Patronize such stores. Contact your local humane society to learn of rejected wild pets and the difficulty in finding homes for them and recount these examples in a letter to your local newspaper, asking people not to buy wild-caught animals of any type.

o Attitudes are crucial to the protection of native wildlife by the people living within their habitat. Killing of animals for food and sale as pets has increased in recent years as international trade provides worldwide markets. It has become all the more important for wildlife to be valued and protected by people living in their range. Effective education is a key. A program in Saint Lucia, an island in the West Indies, is run by Paul Butler, working for the organization RARE. He has taught pride and appreciation of native wildlife and convinced the people living on the island to protect their native parrot, a species in high demand among collectors and numbering only a few hundred in the wild, as well as their forests and other wildlife (see reference below). The smuggling of the St. Lucia Parrot has virtually stopped as a result, and its forest is now protected as the habitat for this national bird. In the rainforests of the Congo, a Gorilla family being studied by a primatologist was filmed. In order to acquaint local people with these animals, the film was shown to them. They had considered these apes to be fierce, dangerous animals, worthy of being killed for the bushmeat market. When they saw the tender affection among family members and the playfulness of the young Gorillas, they were pleased and surprised, saying "They are like us!" They had the forest declared a protected reserve and now teach their children to protect these Gorillas. (This was filmed by Moses Films and shown on National Geographic Explorer, entitled "Living with Gorillas" in 2000.) Write a report about the need for similar programs and find out about others being conducted to educate people about their wildlife. Think of species that would benefit from such programs, and write a short summary of an education program you think would be effective for an individual species or group of species. For example, turtles are being heavily exploited for meat and the pet trade throughout the world, endangering many species. If they were better appreciated in their native lands, especially Southeast Asia, where tradition and folklore hold them in high esteem, their future might be brighter. Design a poster and educational brochure about Asian turtles that could be distributed in Viet Nam, Laos, China and other countries where turtles are being captured in enormous numbers.

o While great profits can be derived from the sale of wildlife, even greater ones can come from tourism. Elephants killed for their ivory bring the hunter a one-time profit of several thousand dollars, but tourism centered

around elephants can benefit local people throughout the long life of the elephant, a life of some 60 years, totaling $100,000 or more. The capture of rare parrots, likewise, is far less profitable than ecotourism, which is worth 100 times or more the value of their sale in the pet trade. Whale meat is far less valuable than live whales that are whale watched. Whale watching now earns $1 billion per year worldwide from the 9 million people who take part in excursions in almost 90 countries, according to the International Fund for Animal Welfare. Think of other examples of non-lethal or non-invasive programs that benefit wildlife and ones that might be started to provide local people with income without harming wildlife. Another form of non-lethal business concerning wildlife involves the placement of videocameras in wild habitats, connected with the Internet. Internet users pay a small fee to see live views of the animal or scene, or to access the website for more films and information. South Africa's national parks are profiting from such a system, and the potential is great for other such videocamera placements. Videocameras can be solar-powered, as engineered by Daniel Zatz in Alaska, who has placed these cameras near bear feeding areas, with the images sent to a museum in Washington state (seemorebears.com). They also have the advantage of not injuring or invading the habitat of shy species which might be disturbed by large numbers of tourists. Think of species that might benefit from videocameras in their habitats. Examples might be wild parrots at their nests or Tigers filmed in national parks along trails.

Books and Publications
Films

Trade: Books and Publications

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Trade: Films

All films are described in detail in the Video section.

General: "The Business of Extinction," produced in 1977, is a classic film on wildlife trade and is extremely hard-hitting, showing smuggling and animal cruelty in the wildlife trade. "The Rangers of Nepal" profiles the bravery and dedication of Nepalese rangers who protect Indian Rhinoceros, Tigers, Asian Elephants and other animals from poachers. "Wildlife for Sale. Dead or Alive" is a Canadian Broadcasting Company film documenting the multi-billion dollar trades--legal and illegal--in wildlife that endanger thousands of species worldwide.

Ivory trade: "Echo of the Elephants," "Elephant," "The Elephants of Tsavo" and "Daphne Sheldrick and the Orphans of Tsavo" all deal with the slaughter that elephants endured during the 1980s and the effects on their populations and behavior. These sensitive and intelligent animals are traumatized when a family member is killed. The last film concerns the orphan elephants, tiny victims of the killing for ivory, affectionately cared for by Daphne Sheldrick in Kenya.

Fur and Traditional Medicine Trade: "Empire of the Red Bear" is a series about Russian wildlife that includes the discovery of two dead Siberian Tiger cubs who starved to death when their mother was killed. "Tiger. Lord of the Wild" profiles many of the activists trying to stop the trade in Tiger pelts and body parts in India and elsewhere. "Giant Otters" was filmed in Guyana, one of the few places left where these animals can be seen because of their killing for fur throughout their South American range, which is discussed.

Whaling**,** Sealing and Sea Turtle Killing: "The Great Whales," "Return of the Great Whales," "Blue Whale: Largest Animal on Earth," "Sperm Whales: The Real Moby Dick" and "Whales Down Under" all discuss the effects of whaling on the great whales. The latter film focuses on the Southern Right Whale, a species heavily hunted and only beginning to recover 50 years after receiving protection. "Sea of Slaughter" is based on Farley Mowat's history of the decimation of wildlife along the North Atlantic coasts. Walrus, whales, seals, sea mink, seabirds and other species that teemed in these waters in colonial times were killed for market sales--several species to extinction. "Long Live the Turtle" is part of a series on Japanese wildlife. "In the Shadow of Fujisan" discusses Japanese killing of sea turtles and their trade in these animals, as well as whaling and dolphin-killing. "Ancient Sea Turtles Stranded in a Modern World," by the Sea Turtle Restoration Project of Earth Island Institute, chronicles the many threats to sea turtles, especially drowning in shrimp nets, urging remedial effort to protect them.

Cage Birds: "Bird Traffic" is an excellent expose of the illegal capture of Salmon-crested Cockatoos at the roosts in Indonesia, showing the trauma and cruelty of their caging and shipment to Singapore and other Asian markets, endangering the species. "Caribbean Cool" is a film about the work of Paul Butler in St. Lucia and other Caribbean islands to protect the native parrot and its habitat. Children are taught about the parrots and dress in parrot costumes, singing songs about these birds and other wildlife of the island. The parrot is the national bird and is given much publicity and positive attention on the island.

Predator Prejudice

Project Summary

The purpose of this project is to research the general subject of predator prejudice and its effect on predators in various parts of the world. Read the material below and the Persecution and Hunting chapter in this book. The subject in general or a particular predator which has become endangered as a result of prejudice and persecution will be selected for a short report, including information on past and present distribution, control measures taken and the present status of the species.

Background

In the United States, Grizzly Bears, Gray and Red Wolves were eliminated from 98 percent of the country south of Canada by European settlers in control programs using poisons**,** guns and traps. Today, through natural recolonization and reintroduction, these predators are reoccupying small portions of their original ranges. Unfortunately, outside national parks, these animals are encountering prejudice. Local livestock owners, whose ranches surround the protected national parks and forests, oppose their presence. Livestock owners near one Gray Wolf reintroduction site in Yellowstone National Park in Montana attempted unsuccessfully through a lawsuit to have wolves removed from the park. Wildlife research over the past century has found that wolves rarely kill domestic livestock, and their predation on deer, elk and other ungulates keep these species strong and healthy. Grizzly Bears are mainly vegetarian, with occasional predation on small rodents or the calves or fawns of elk or deer, yet they have been hunted out of all but about 1 percent of their original range in the western United States south of Alaska.

Predator prejudice is common throughout the world wherever livestock is grazed in large numbers. In Ethiopia in East Africa, the Simien Wolf, a small canid that preys mainly on rodents, has been killed off by livestock owners who mistakenly believe them to present threats to their sheep and cattle. The species is near extinction. Likewise in South America, Europe and Asia, predators have been heavily persecuted, with wolves, bears, big cats and others eliminated from areas near human habitation and many wilderness areas.

Seals, sea lions and otters are also the object of prejudice from fishermen who believe that they take too many fish. In fact, they often prey on fish that are not taken for human consumption, many of which are predators of food fish. The Caribbean Monk Seal was persecuted to extinction, and its close relative, the Mediterranean Monk Seal, is now critically endangered as a result of killing by fishermen. Its remaining populations, numbering fewer than 1,000

animals, hide in caves along the coasts. Sea otters eat invertebrates that eat kelp and sea grass, thereby playing a key role in maintaining these ecosystems in which fish and shellfish flourish, but abalone fishermen consider them unwanted predators.

Birds of prey have also been persecuted as threats to livestock or because they competed for the same food as humans. The Bald Eagle was killed for a bounty in many parts of the United States because it fed on fish, causing fishermen to believe that it was an unwelcome competitor. Hawks and eagles around the world are shot and poisoned by ranchers and others, reducing many species to endangered status. In some areas, birds of prey are shot on sight. Legal protection for these birds has only recently been enacted in the United States, but many other countries fail to accord protection. They have an important ecological role to play by preventing rodents, snakes and other species from multiplying to pest proportions. The majority of species specialize in killing rodents, which helps farmers raising and storing grains.

Likewise, bats prey on insects and are important pollinators of plants, but they are persecuted in most parts of the world.

Snakes are also important predators of rodents, yet they, too, are routinely killed around the world. They are either considered pests or inspire great fear that they might present a threat to human beings. Snakes tend to be afraid of people, who are not their natural prey, and if left alone, will not attack.

Crocodiles perform a useful role in preying of overpopulated fish, yet they are killed as potential threats or for the leather trade. A majority of crocodile species are now endangered.

Activities

o Research: Using the sources listed in the Persecution and Hunting chapter, and others listed below, as well as those available in your library and through computer on-line searches, learn about the subject in general. Consider the following aspects of the issue:

1. Laws have been enacted since the Middle Ages in Europe encouraging the killing of predators and even punishing those who did not kill and deliver their hides to authorities. Many of these laws have been altered over the years and now remain in the form of bounties paid for pelts, and regulations permit and encourage persecution of predators. Are there state laws that allow persecution of predators, including endangered species? (Read the US Endangered Species Act and the Marine Mammal Protection Act to find examples of legalized killing of species considered predators of livestock or fish.)

2. What attitudes prevail in various parts of the world toward predators? While negative fears and hatred dominate in many areas, trends are changing in many countries. North American native tribes traditionally revere predators and incorporate them into their folklore. Europeans settling America had an opposing view, instituting predator control programs. What is unusual about the legal status and attitude toward the Gray Wolf in Italy? (See Persecution and Hunting chapter.) What happens to endangered Cheetahs when white ranchers who hate predators take over land in Namibia and South Africa? What education programs are taking place to change prejudices? The reintroduction in the United States of both Gray and Red Wolves was a result of this new view and the application of the US Endangered Species Act, but education programs have had mixed success. In some areas, such as Yellowstone National Park, however, tourists are coming in large numbers, spending money in local towns, and watching the Gray Wolves in an open environment considered the best "wolf watching" area in the world. Could tourism help save predators? The survival of predators depends entirely on attitudes of people living in their habitats.

3. Biological Studies: Studies on Gray Wolves in Alaska in the 1940s by Adolph Murie began a major change in knowledge of these animals and their relations with their natural prey that overturned previous misconceptions, many of which assumed that they were destructive to their prey. These studies have been augmented by other biologists on various predators throughout the world, confirming the important and positive role that predators play in ecosystems.

What studies can you find that examine the biological role of predators of various types, including birds, fish (such as sharks) and reptiles (such as snakes and crocodiles)?

4. Economic Damage: Control programs against predators are based on real or assumed damage to livestock or other property or assets, but they have rarely been based on fact. Exaggeration and fear have distorted estimates of actual losses to predators. Moreover, the ranchers or herders tend to release their livestock into the wild without guard dogs or other protection. When their animals are found dead, predators are blamed, when proof is often lacking. When livestock is guarded by dogs or fences, or housed in buildings or pens at night and when giving birth, mortality is usually very low. Unfortunately, US government programs, such as the Animal Damage Control (ADC) Division of the Department of Agriculture, routinely trap and poison hundreds of thousands of animals each year without proof of their predation on livestock. Contact the ADC and ask how many traps, how much poison and how many animals of all types have been killed in recent years. Also ask for the numbers and species of no-target animals, such as endangered Grizzly bears, Bald and Golden Eagles and other wildlife, taken in these programs. Ask the ADC how it avoids killing endangered animals? How much is spent on these programs per year, and what alternative programs could protect livestock in non-lethal ways, including guard dogs or other guard animals, such as llamas and donkeys, and by providing information on protecting livestock for far less money?

o Reports and Discussion: Select the subject of predator control in general for a report based on the information you have gathered in accordance with the categories above. Discuss this issue in class.

o Select a particular species that has been persecuted to endangered or threatened status by predator control programs. What was the original range of the species? What is its present range? What are the natural prey species of the animal and its habitat? When did control programs begin to eliminate the species and what were the reasons on which they were based? Was the species gradually, or rapidly, reduced in both numbers and range? Were control methods directed at adult animals only or on the young, such as killing pups in the den? What is the natural behavior of the animal in terms of its social nature with others of its kind, number of young, number of breeding adults in a group, whether it is solitary, and whether it can easily recover its population once control is stopped or tends to decline to extinction? What are the attitudes of the people who live within its habitat? What is being done to help the species? What do you think should be done to prevent its extinction?

o Conservation: Describe various means of protecting predators that are persecuted. For example, bats have been conserved through education programs in local communities and schools about their ecological role and how to bat-proof buildings. Ecotourism is another means of protecting bats, since their flights at dusk can be spectacular. The economic value of predators in controlling insects or rodents, for example, is an important argument in their favor. Many approaches are needed, depending on the attitudes held by the local people, the type of damage alleged and the economic factor. In some cases, the same species can be reviled in one part of the world and admired in another. The Gray Wolf is now a valued and protected predator in a growing number of countries, but in Russia and other countries, it is still tainted by folklore that bears no relation to fact. Make recommendations for the conservation of the Gray Wolf or another species in a country where it is persecuted. Write a brochure and design a poster for a species of your choice that would educate the public about why this species should not be persecuted.

Books and Publications
Films

Predator Prejudice: Books and Publications

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Predator Prejudice: Films
All films are described in detail in the Video section.

Wolves: "Crying Wolf," "Wolf" (Spain), "Wild Wolves" (general), "Return of the Wolves" (Yellowstone National Park). All discuss the persecution, disappearance from large portions of its original range, and facts about the Gray Wolf's true ecological role and behavior. "Wild Dogs of Africa" is a sensitive portrayal of these endangered canids, including discussion of their persecution by ranchers, especially in southern Africa.

Bears: "Grizzly and Man--Uneasy Truce" (US persecution); "Grizzly Bears: Losing Ground" (British Columbia, Canada). These two films show the extreme ignorance and fear with which these bears are seen in North America, resulting in their killing for presumed threats and a lack of commitment on the part of the public and some officials to preserve the species.

Seals: "Orphans of Time" concerns the two surviving species of monk seals, the Mediterranean and the Hawaiian, both of which are highly endangered. "Seals--the Salmon Eaters," a film about seals in the Pacific Northwest (primarily Washington state) describes the intense hatred felt by fishermen toward seals and their desire to kill large numbers of them to increase the take of salmon.

Birds of Prey: "Anna and the Honey-Buzzards" is an inspiring film about a woman who has protected migrating birds of prey in southern Italy from being killed illegally by hunters who shot them from bunkers on hillsides. She has been joined by others who help her patrol the area since the film was made. "Eagles: The Majestic Hunters" is a beautiful film about these superb hunters and their life histories. It includes shocking footage of persecution of eagles in various parts of the world where they are killed and nailed to fences or poisoned.

Snakes**:** "Snake" is an excellent film to dispel irrational fears about snakes, 85 percent of which are harmless to humans, and to show their value in controlling rodents and other snakes.

Bats: See film list at end of "Bats: Ecologically Important Mammals" project.

Saving the American Elm and Chestnut Trees
Project Summary
This is an action-oriented project in which students or individuals obtain seedlings of these endangered trees and plant them to help restore the species, which were once widespread. For those living in areas outside the range of these species in Eastern North America, other threatened trees may be planted.

Background
Both the American Chestnut and the American Elm have been decimated by diseases brought to the United States on

wood or trees. Millions of these magnificent trees have died, but within the past decade, plant geneticists have produced disease-resistant types. The Elm Research Institute distributes seedlings grown from trees that have natural resistance to Dutch Elm Disease and have survived exposure to it. The tree that is cultivated by this institute is called the American Liberty Elm, and since 1983, more than 250,000 seedlings have been distributed to organizations, such as the Boy Scouts of America and others, who grow them from seedlings, then sell them to local towns, public parks and organizations for planting. The organization hopes to bring back the American Elm to Main Street America. The Elm Research Institute also provides advice on saving diseased elms. One teacher in Michigan organized local neighborhood groups who located diseased trees and succeeded in treating them to prevent their deaths.

The American Chestnut, a massive tree of eastern forests, made up about one-fourth of the original eastern forests in colonial times. It provided nuts that were fed on by populations of the now extinct Passenger Pigeon, American Turkeys, Black Bears, squirrels and other wildlife. These trees grew to heights of 100 feet or more and had deeply furrowed trunks, earning them the name "Eastern Redwood." Their near-extinction has been catastrophic to forest ecosystems. The Chestnut Blight that attacked them was first seen in 1904 on American Chestnut trees lining avenues near the Bronx Zoo, and apparently entered the country on another species of chestnut tree imported for botanical purposes. Like Dutch Elm Disease, this disease cuts off nutrients and water, gradually killing the trees. It has killed almost all American Chestnut trees in the east, and only a hundred or so remain in southern Canada. Some trees that were planted outside the natural range, such as in Oregon, survive. The stumps of American Chestnuts still produce sprouts that can grow up to 20 feet tall until they die from the disease.

Old-growth Longleaf Pine forests once covered millions of acres in the Southeast, with one of the world's richest diversity of forest floor plants and native wildlife, including the Ivory-billed Woodpecker. These forests have declined to 2 percent of their original size, and many of their former denizens are endangered or gone. The Southern Live Oak, a magnificent semi-evergreen tree that has a massive, spreading crown and twisted branches, has declined in many areas within its natural range. These native trees should be brought back through massive planting programs. In more Western areas, Redwood, native oaks and many types of pines and conifers have declined from former abundance and should be replanted.

Activities

o Help conserve endangered trees, such as the American Elm. Plant American Liberty Elms if you live in eastern North America. The Elm Research Institute will send an application to those who wish to receive 500 to 1,000 free elm seedlings. Teachers who wish to participate in the program must pledge several years commitment in order to care for the trees prior to their sale. The trees are guaranteed if properly maintained, and the Elm Research Institute will replace any trees that die. This is potentially a fund-raising program because the trees can be sold after a few years of care. The Elm Research Institute can be contacted at 1-800-FOR ELMS; Fax 603-358-6305; website: http://www.forelms.org.

o Plant American Chestnut trees if you live in the range of the east where this tree once grew. The American Chestnut Foundation was formed in 1983 to save this species through selective breeding of resistant strains. At present, they have succeeded in growing resistant trees and are developing seeds from these trees. They distribute kits of resistant seeds, which can be grown in one™s back yard, for $50. When they are old enough, they can be pollinated with pollen from blight-resistant trees being cultivated in Virginia. This is somewhat more complex than the growing of American Elms, but for a high school class, it would be an excellent way of learning about plant reproduction while helping to save an endangered native tree. A 17-year-old resident of Somerville, New Jersey, Timothy Van Vliet, is an enthusiastic supporter of the program and has grown a number of Chestnut trees in his back yard, one of which is 10 feet tall. With more people like Timothy Van Vliet, the American Chestnut may return to its former abundance. The American Chestnut Foundation can be contacted at P.O. Box 4044, Bennington, VT 05201, or telephoned at 1-802-447-0110. Membership in the organization is $40.

o Plant other threatened native trees. Those who live in western North America can help a rare or declining species of tree. Contact the Redwoods National Park (1111 Second St., Crescent City, CA 95531; and the Save-the-Redwoods

League (114 Sansome St., San Francisco, CA 94104) for information on obtaining seeds and seedlings. If one lives in the Pacific Northwest, native trees, such as Western Hemlock, Sitka Spruce and Western Red Cedar, have been reduced by 95 percent because of logging. Replanting these magnificent trees will help to bring back these forests and provide habitat for the threatened Northern Spotted Owl, Marbled Murrelet and other native species. Help protect the stands of these forests that remain by contacting organizations such as the Native Forest Council (P.O. Box 2190, Eugene, OR 97402); Save America's Forests, Washington DC (202-544-9219); and The Nature Conservancy (1815 N. Lynn St., Arlington, VA 22209; (703-841-5300).

Read "Smiles of Vanished Woods," Chapter 11 of *Noah's Garden. Restoring the Ecology of Our Own Backyards*, by Sara Stein, which discusses the importance of planting only native trees and the threat of exotic species, such as the Norway Maple, which can crowd out indigenous species. This book also stresses the importance of preserving old trees with hollow trunks and snags that wildlife can use and of planting understories of native bushes that hundreds of species of wild animals use for shelter and feeding.

Books and Publications

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Peck, Robert McCracken. 1990. *Land of the Eagle. A Natural History of North America*. Summit Books, New York.

Stein, Sara. 1993. *Noah's Garden. Restoring the Ecology of Our Own Backyards*. Houghton Mifflin Co., Boston, MA.

Bees and Other Pollinators

Project Summary

Study the behavior of bees, using written materials, films and observations of actual beehives. Learn about plants that would become extinct without pollination by bees and what species of bees are indigenous to your area, especially those that are rare or declining. Learn what plants and habitats these species require and, if possible, plant their preferred flowers and erect a bee house.

Background

Many native bees in North America are important pollinators. A growing number are becoming rare as a result of pesticides, competition with non-native bee species and destruction of natural habitats. Very few types of bees sting humans. There are 500 species of native bees in New England, for example, but the most commonly seen bees are the European honeybees used to pollinate orchards and other crops. Some native bees are green, blue or red, and many are as small as flies. Others are twice the size of bumblebees. A few are nocturnal.

The communication system bees use to identify sources of nectar and pollen to one another was first discovered in

European Honeybees (*Apis mellifera*). When one bee locates a source of food, such as a flowering tree, it returns to the hive and through a complex series of movements with its feet, called dances, communicates to the other bees the location of the food source. The type of dance performed by the bee indicates the distance from the hive to the pollen and nectar. This system of communication involves a highly sophisticated integration of perceived and memorized information and was first discovered by an Austrian scientist, Karl von Frisch, a world-renowned animal behaviorist. He wrote two books on his discoveries: *Bees, Their Vision, Chemical Senses and Language*; and *The Dance Language and Orientation of Bees*. (See Reference list below.)

Methods

Learn about pollinators and their ecological importance and behavior. *The Natural History of Pollination*, by Michael Proctor, Peter Yeo and Andrew Lack, describes bee communication in terms of the extreme importance of bees as the pollinators of many native plants. Consult various reference books that describe bee behavior in detail. "Dancing the Good News" in the book, *Alien Empire. An Exploration of the Lives of Insects*, by Christopher O'Toole, clearly illustrates this remarkable phenomenon. This book is a companion to the excellent television series of the same name shown on Nature, the PBS program produced by WNET and filmed by BBC, which shows the dance of the honeybees as well as the behavior and ecology of many insect pollinators.

Activities

o Take a field trip to see a beehive. Teachers may contact local nature education centers, Audubon societies, state Natural Heritage Programs and US Department of Agriculture extension services to learn about local bee hives that could be visited.

o Contact the Natural Heritage Program connected with your state wildlife department, and find out which species of wild bees live in your area and which species are rare or declining. Discuss these species and what can be done to help them. What plants would become extinct if pollinating bees were to disappear? (*The Natural History of Pollination* is a good source of information for this subject.)

o Plant flowers and flowering trees that attract native bees. Find out which plants are preferred by bees in your area. Do not use pesticides or herbicides of any kind.

o Erect a beehouse in your back yard to attract native, stingless bees. A few holes drilled in scrap lumber and mounted under the eaves of a house, or some paper straws glued into a milk carton and placed on a tree branch, will entice native bees. To attract the large and colorful Bumblebees, build a house such as the one described in *Attracting Backyard Wildlife*, by Bill Merilees.

o Using *The Forgotten Pollinators*, by Stephen L. Buchmann and Gary Paul Nabhan, *The Natural History of Pollination* mentioned above, and other references on insects listed in the Books and Publications section of the Appendix of this book, select one or more pollinators, whether butterflies, ants or other insects, birds, bats or primates. Learn about these pollinators and which plants they pollinate, especially those that are threatened with extinction.

o By consulting the books mentioned above, the main text of *The Endangered Species Handbook*, and books listed in the Books and Publications section of this book, learn about the importance of pollinators in maintaining the world's ecosystems and how crucial it is to protect pollinating animals. Describe a pollinator or group of pollinators that are crucial to an ecosystem. For example, read the section in the Forests chapter in *The Endangered Species Handbook* concerning tiny wasps that pollinate a wide variety of figs which, in turn, nourish hundreds of species of wildlife. Learn about mammals, such as bats that pollinate many types of plants, through descriptions in this book and others listed in the project, "Bats, Useful Insectivores and Pollinators." Find an example of a species of plant that has lost its natural pollinator through extinction and now exists only through human intervention.

o The economic importance of pollinators has been calculated in several books and studies. In *Nature's Services:*

Societal Dependence on Natural Ecosystems, edited by Gretchen Daily, for example, the role of wild pollinators, such as insects and other animals, is valued at $117 billion worldwide. This means that the wild bees, ants and other species that pollinate commercial crops, such as fruit trees and wild plants, perform tasks that are worth $117 billion per year to the world's economy. The authors of *Forgotten Pollinators* estimate that pollinators save farmers in the United States an estimated $1.6 billion annually. Select a farm crop and find out from local US Department of Agriculture offices whether wild species of insects or other animals pollinate it. Through data from the US Department of Agriculture and almanacs, calculate the value of this crop and the losses to farmers should the wild pollinators disappear.

o Wild pollinators are in decline in many areas as a result of heavy pesticide use, which kills insects and other wildlife, and habitat loss, as in the cutting of forests, which causes declines in bats, tropical birds and insects. The Forests chapter discusses this in detail. Write a report on this problem, giving as many examples as possible of the loss in these essential species and the types of threats that pollinators face.

o Select a pollinator**,** such as a type of butterfly**,** and learn about what plants it pollinates. Does it pollinate a single species of plant or many species? Where does it live? What is its status? If threatened, how can it be helped?

Books and Publications

Buchmann, Stephen L. and Gary Paul Nabhan. 1996. *The Forgotten Pollinators*. Island Press, Washington, DC.

Daily, Gretchen (ed.). 1997. *Nature's Services. Societal Dependence on Natural Ecosystems*. Island Press, Washington, DC.

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Films

"Alien Empire. An Exploration of the Lives of Insects." 1995. PBS. WETA. 1 hour.

"The Private Life of Plants." 1995. TBS/BBC. 6 hours. (Part 3, "The Birds and the Bees," concerns pollination.) Available from Discovery Channel School: 888-892-3484; www.discoveryschool.com.

Learning Animal Anatomy Without Dissection

Project Summary

Learn about animal anatomy in non-lethal ways. New communication technology may provide better knowledge about anatomy, through videos and virtual learning, than does dissection. Learn about these new resources and discuss their use in the classroom.

Background

In a growing trend, biology classes are being taught about the anatomy of frogs, cats and other animals from CD-ROM software, such as "Digital Frog and Cat Lab," rather than killing live animals for dissection or dissecting dead animals. An estimated 6 million vertebrates, half of which are frogs, are dissected each year by high school students, who are often so upset by the experience that they turn away from future science courses. Such school projects are inhumane, often requiring that frogs be killed by the student, for example. Moreover, frogs are in decline in the wild from a variety of causes, including the capture for such dissections. Their populations need protection. Many of the cats killed for use in high school dissection had been house pets that were illegally caught and sold to animal dealers in the United States and Mexico. Humane organizations have been promoting non-lethal substitutes for many years.

Activities

o Find out if your state's education department allows use of alternatives to animal dissection in classrooms.

o Review a copy of "Digital Frog and Cat Lab" or another software from the organizations below. The National Geographic Society sells various films, film-strips and other materials on animal anatomy. The lessons include function, taxonomy and structure. The Society's "Educational Services" catalog lists these products (P.O. Box 98019, Washington, DC 20090; 800-368-2728; www.nationalgeographic.org).

o Contact the American Anti-Vivisection Society (Suite 204 Noble Plaza, 801 Old York Rd., Jenkintown, PA 19046, 215-887-0816), which publishes the brochure "Animals in Education: An Outline for Student Activists" and distributes audio-visual materials. Also contact the American Fund for Alternatives to Animal Research (175 West 12th St., Suite 16G, New York, NY 10011, 212-989-8073) and the American Society for the Prevention of Cruelty to Animals (ASPCA) (441 East 92nd St., New York, NY 10128, 212-876-7700), which publishes the pamphlet, "ASPCA Guidelines for Student Experiments Involving Animals." The Animal Legal Defense Fund (1363 Lincoln Ave., San Rafael, CA 94901) has a "Dissection Hotline": 800-922-FROG, and publishes the brochure "Objecting to Dissection: A College Students' Handbook." The Humane Society of the United States (2100 L St., NW, Washington, DC 20037, 202-452-1100) publishes the brochure, "Does the Idea of Dissecting or Experimenting on Animals in Biology Class Disturb You?" Also, the National Anti-Vivisection Society (53 West Jackson Blvd., Suite 1550, Chicago, IL 60604, 312-427-6065) publishes "Reverence for Life: An Ethic for High School Biology Curricula" and "School Project Packet." The Student Action Corps for Animals (P.O. Box 15588, Washington, DC 20003, 202-543-8983) is dedicated to empowering young people in high school to work effectively for animal rights and acts as a communication network; it began the national "Say No to Dissection" campaign in 1984 and publishes *SACA News* and brochures such as "Say No to Dissection," "Suggestions for High School Student Animal Rights Groups" and "1-0-1 Non-Animal Biology Lab Methods."

Attitudes and Ethics

Project Summary

Examine the list of principles related to the treatment of animals entitled "An Animal Bill of Rights" (see below) and consider how these principles relate to declining and endangered species. Suggestions are given on how to use this document for classroom discussion or reports on endangered species.

Background

Our attitudes about animals have undergone radical changes in the past few decades. For most of human history, people have believed, like the philosopher René Descartes, that animals were merely machines, blindly obeying instincts. The opinions of many people have been greatly changed by the results of work with animals, for example, the intelligent Chimpanzees who make tools and exhibit many of the same emotions that humans have, such as fear, love, anger, joy and even despair. Elephants have also shown extraordinary qualities of altruism, and many examples

of their intelligence have been documented by zoologists. Whales and dolphins, too, have been shown to be intelligent and extremely devoted to one another.

Attitudes towards animals are also changing rapidly as a result of films and books and closer contacts with domestic cats and dogs. The popularity of house pets, with whom we form strong bonds, has encouraged a growing number of people to regard animals as having many of the same emotions as humans, and their friendship and loyalty toward us have been an inspiration to many. The popularity of nature films and books has educated the public to have a greater affection and respect for wild animals and a desire to protect and appreciate them. Still, many people treat animals as having neither sensitivities nor even the ability to feel pain. Fur trapping, research involving cruel experiments on animals, and baiting or attacking animals as an amusement are examples of a lack of compassion. A comment by a Canadian forester represents such a point of view that is, fortunately, disappearing: "Our instinctive attitude toward other species seems to range from indifference to antipathy . . . Concern for other species, particularly for those that have no immediate economic value to us, is a learned response, one we still struggle with" (Don Gayton, British Columbia Forest Service, "Terms of Endangerment" article in *Canadian Geographic*, May/June 1997).

Having a set of values and principles is a logical step in reevaluating how we treat animals--domestic and wild. The famed British zoologist Desmond Morris, in his book *The Animal Contract* (Warner Brothers, 1990), recommends 10 principles that human beings should adopt in their treatment of animals. This book discusses in detail the basis for the principles and gives many examples of our treatment and mistreatment of animals. He states that brutality to animals affects all our conduct and dealings with humans as well, and that a culture that is sympathetic to animals is a culture that is sensitive and caring in all respects. Moreover, he believes that a culture that feels a kinship with animals will be a culture that keeps faith with its roots in recognizing that humans are also animals, relatives of other species. These principles, as related to threatened species, are discussed below. They could also be used as interesting subjects for classroom discussions or for reports.

An Animal Bill of Rights

1. No animal should be endowed with imaginary qualities of good or evil to satisfy our superstitious beliefs or religious prejudices.

2. No animal should be dominated or degraded to entertain us.

3. No animal should be kept in captivity unless it can be provided with an adequate physical and social environment.

4. No animal should be kept as a companion unless it can adapt easily to the lifestyle of its human owner.

5. No animal species should be driven to extinction by direct persecution or further increases in the human population.

6. No animal should be made to suffer pain or distress to provide us with sport.

7. No animal should be subjected to physical or mental suffering for unnecessary experimental purposes.

8. No farm animal should be kept in a deprived environment to provide us with food or produce.

9. No animal should be exploited for its fur, its skin, its ivory or for any other luxury product.

10. No working animal should be forced to carry out heavy duties that cause it stress or pain.

Source: *The Animal Contract* by Desmond Morris. Warner Books. 1990.

Although many of these principles relate to domestic animals and can be discussed in another setting, others relate to our treatment of wildlife, including endangered species. Discuss the way in which these principles apply to threatened species.

Activities

o Principle number 1 could apply to wolves and bats, which are considered by many societies and individuals to be evil. Read the Persecution and Hunting chapter in this book for other such cases and consider the implications of such prejudices on the survival of many animals.

o Principle number 2 can also be applied to endangered species in that Lions (now considered Vulnerable species), Tigers, chimpanzees and elephants (all Endangered species) are trained to perform tricks in circuses that degrade them. Brown Bears used by gypsies in Europe and Asia are another example. They are dragged about by leashes attached to nose rings and trained to perform extremely unnatural acts, such as "dancing" on their hind legs. Discuss this principle and learn how circus animals are trained and how they are treated. Contact organizations such as PAWS (Performing Animal Welfare Society, P.O. Box 849, Galt, CA 95632) or the Animal Welfare Institute to learn more about this.

o Principle number 3 can apply to zoos that house endangered species. If the captive conditions do not allow the animals adequate physical and social environments, they would be considered to be violations of these principles. Examples might be the keeping of an elephant, a highly social species, by itself, in a small enclosure without water to bathe in or space to exercise. These animals are also chained at night in many zoos. Are there animals at your local zoo kept in such conditions?

o Principle number 4 can be applied to wild pets of many species that are kept in unnatural conditions. Tigers and other big cats, wild-caught parrots and many reptiles and amphibians are kept in peoples' back yards in cages or in indoor conditions that are highly unhealthy or psychologically traumatic for the animal. Many states ban various wild pets for this reason. Read the Trade chapter in this book for more information on wild pets and zoos. Find out the laws of your state or country regarding the keeping of exotic pets, especially endangered species.

o Principle number 5 is an extremely critical one in relation to endangered species. Although the US Endangered Species Act specifically addresses the issue of driving species to extinction as unacceptable, the law has been weakened by its opponents and faces further weakening. Moreover, only listed species receive such protection. Many threatened and endangered species that are not listed on the US Endangered Species Act receive no legal protection. In other countries of the world, such as Canada, no law prohibits driving a species to extinction or protects endangered species. Human overpopulation is a major cause driving species to extinction. This is an extremely important moral dilemma, one that is being faced by countries such as Indonesia, which has relocated people from overpopulated islands, such as Java, to areas still forested, such as Borneo and western New Guinea. These new immigrants are burning forests, with the encouragement of the Indonesian government, to create farms and grazing land for livestock. In the process, they are driving endangered species, such as the Orangutan, toward extinction. What should societies do in these circumstances, which will become more and more common in the future?

o Principle number 6 states that causing pain or distress in animals for our amusement is reprehensible and must not take place. Most examples of such cruelty involve domestic animals, such as steers in bull fights, roosters in cockfights and pit bulls in dog fights. Consider situations in which threatened or wild animals are used in such ways. For example, Asian bears are abused in street shows, and Tigers and elephants suffer in circuses. Hunting rare animals for sport might be considered to fall into this category, especially when it is carried out by means that do not usually kill quickly, such as by bow and arrow, and when it is not done for food, but for amusement.

o Principle number 7 concerns causing unnecessary pain for experimental purposes. Such experiments often involve the use of threatened animals. Chimpanzees and monkeys are involved in painful experiments to test drugs, in

simulated car crashes or other research. The use of these animals is justified by many research laboratories and others as being important because it can help human beings in various ways, such as finding cures to diseases. However, many experiments are unnecessary and repetitive of already published research. Does the treatment of these animals, especially long-lived chimpanzees who must spend a lifetime that can reach 60 or more years in sterile confinement, justify the research, or are there alternatives to using these animals? (Contact the Animal Welfare Institute for its published reports and articles on this subject.)

o Principle number 9 regards exploitation of animals for furs, skins and other luxury items. Many threatened species are legally traded for such purposes. All the wild cats that are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild of Fauna and Flora (CITES) may be traded with export permits, for example. The trade in elephant ivory during the 1980s nearly caused the extinction of both the African and Asian species. In 1989 all ivory trade was banned by CITES. Today, many countries want to reopen trade in African ivory, claiming they have stockpiles and overpopulation of elephants in some areas. Discuss the ethics of killing animals for luxury goods and select a species that is threatened with extinction as a result of such killing. This principle could also apply to the trade in live wild pets that threatens many species. Read the Trade chapter in this book for more information.

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Film

"The Animal Contract," based on the book by Desmond Morris. Garner MacLennan London and Lifetime Pictures in association with Island Visual Arts and G.C. Films, UK.

Wildlife Music

Project Summary.

People once thought that animals were "dumb" because they could not speak in human language or that the seas were silent because we were unable to hear their sounds. Many still think that birds sing for people. We now know that wild animals communicate with one another and other species in thousands of different sounds. This project will acquaint students and others with many of these sounds. They have definite purposes and can communicate a wide variety of messages, whether territorial, warnings to members of their own species, mating calls or other meanings we have yet to understand. Human activities are having negative effects on the communications of some animals, even causing mortality. This project will encourage appreciation of the great variety of animal sounds, especially those of disappearing species. Means of preventing interference with animal communication and working to reduce human-created noise will be explored.

Background

A chorus of bugles as flocks of Sandhill Cranes take flight, the eerie violin-like songs of Humpback Whales or the croaking of frogs can evoke emotion and deep appreciation. Human response to wildlife songs reflects the universality of music. Virtually all human societies have their own music (see Milius 2001). Just as we are drawn to the sounds of nature, animals have been attracted to human music. The now-extinct Laughing Owl of New Zealand would fly close to a person playing an accordion after dusk, remaining in the vicinity until the music stopped (see Fuller 2001). Researchers in the Pacific Northwest have dangled microphones playing music from their boats and found that dolphins and Killer Whales approached and listened for long periods. The mournful, musical howls of wolves caused fear in the superstitious medieval times, but today they are appreciated as true animal songs, each wolf contributing a slightly different melody. In fact, when a recording of wolf howls was released during the 1970s, the music critic of *The New York Times* judged the musical talent of each wolf singer. (Wolf Education and Research Center: www.wolfcenter.org provides information on howling.) Songs play an integral role in wildlife communication and survival. Endangered denizens of American grasslands, prairie dogs, also have complex languages, giving different calls to one another to warn of birds of prey, land predators, humans with guns and other threats. Some bird songs, like those of many birds of paradise, stunningly beautiful birds of New Guinea, are so loud and bizarre that they seem to have been electronically produced. They are designed to penetrate dense foliage for long distances. Bellbirds and howler monkeys of Latin America and gibbons of Asia also sing so loudly that the songs carry for miles in the rainforests. Gibbons mate for life and sing duets in whoops that echo through the forest. Many wildlife songs are used to defend territories or to find a mate. Beluga whales and Mountain Lions communicate with one another in bird-like chirps. Elephants are now known to emit deep sounds, inaudible to humans, which carry for great distances to elephant herds miles away (see Payne 1998). Likewise, bats and dolphins emit ultrasonic sounds to find their prey and to navigate. Some of these are audible to the human ear. Many of these species are now listed as Threatened, however (see Endangered and Threatened Species list in the Appendix).

As the world becomes filled with human-made noise, from the giant engines of ships, planes, trucks and earth-moving machines to jet skis, snowmobiles, snow blowers and chainsaws, wildlife songs and calls are being drowned out. Each Humpback Whale has its own individual song. The males vary the songs each year, and females seem to be attracted to the males who emit the most complex songs. Marine mammals emit a great variety of squeaks, hums, squeals and chirps to communicate with one another and echo-locate, but they can be drowned out by ships, motorboats, jet skis and other human-made sounds. It is critical for the survival of these marine mammals that they be able to communicate.

Some ship noises are even lethal to marine mammals. The US Navy has been testing an anti-submarine sonar called Low Frequency Active Sonar (LFAS). Powerful sonar waves are broadcast underwater to test a means of detecting quiet enemy submarines (see White 2000a). These sonar waves can travel hundreds of miles and be extremely loud. Humpback Whale males have stopped singing or moved away when these waves were broadcast. More ominously, testing in 1995 off the coast of Greece coincided with an unusual stranding of Cuvier's Beaked Whales, resulting in the deaths of these seldom-seen whales. In March 2000, Ken Balcomb, a biologist familiar with sonar, was present in the Bahamas when a stranding occurred at the same time Navy LFAS tests were taking place nearby. Fifteen whales stranded, including Dense Beaked Whales, a Minke Whale and a Spotted Dolphin. All washed up on the shores, and when pushed back into deep water, they were unable to remain upright, clearly unbalanced, disoriented and apparently in pain. Without their hearing, they cannot find their way in the ocean. Nine died. Along with Harvard biologist Darlene Ketton, Ken Balcomb performed necropsies on several whales, finding their ears full of blood. In one case, hemorrhages striped the lungs. Further testing revealed that a whale had suffered a concussion, apparently the result of acute trauma from pressure (White 2000a). A press conference organized by the Animal Welfare Institute following these findings featured Ken Balcomb of the Center for Whale Research and other whale experts, who attested to the fact that LFAS is reckless, unnecessary and lethal to whales. Soon after, the Navy canceled testing of active sonar off New Jersey and also its scheduled tests on Sperm Whales in the Azores (White 2000a). The Navy has not cancelled these tests altogether, however, claiming that more research by Woods Hole Oceanographic Institute is needed to reach a final conclusion.

Bird reproduction has also been affected by the sounds of highway or airplane traffic. Researchers have found that male birds living near such loud noises cannot hear their own songs or those of their rivals and, in a few generations, begin singing songs so different from their instinctive ones that other males do not respond, nor do females, preventing reproduction. Frogs living near highways have also been found to lose their natural calls in the din of traffic noise. It is not known whether these animals have suffered hearing damage or are simply unable to hear fellow creatures over the din. Much of the noise created by human machines could be reduced or eliminated with muffling devices. Design of machines that will not interfere with animal communication should become a priority.

Activities

o Listen to recordings, such as fiMusic of the Birds,**fl** listed below. Visit websites that play animal sounds and songs. One, intended for visually-impaired people, plays bird songs: www.nhest.org; and www.naturesongs.com has many types of natural music. The largest collection of natural sounds in the world is at the Macaulay Library of Natural Sounds at the Cornell Laboratory of Ornithology (www.birds.cornell.edu). It has 150,000 recordings. The British Library's national sound archive has more than 130,000 recordings: www.bl.uk/collections/sound-archive/wild.html). The Nature Sounds Society website (www.naturesounds.org) gives information on other sites. For an academic approach, consult the site of the World Forum for Acoustic Ecology: interact.uoregon.edu/MediaLit/wfae/home/. Watch wildlife films that include songs and calls, especially those of threatened and endangered species, such as birds of paradise, whales, wolves and elephants (see list below and Video section). Write an essay on the songs of one group of species, such as whales, or a particular species, describing the variety of the songs or calls.

o Compare the wildlife sounds heard in environments far from highways and airports with those near them. Take walks in several types of habitats with experts who can identify wildlife sounds, such as frog chirps and croaks, bird songs and insect noises. Tape record the sounds heard and count the number of species in a quiet habitat versus those heard near a busy highway or airplane flight path. Note that each species' song can be heard in normal conditions because of its own frequency and rhythm. Discuss the effect of noise on these species, and describe the various calls heard without interference.

o Learn about means of lessening human-created noise. Write the Environmental Protection Agency (EPA) in Washington, DC (see Organizations list, Teachers™ Aids section) for information on noise pollution and how existing engines can be muffled for quieter substitutes. For example, electric-powered lawn mowers and leaf blowers make far less noise than gas-powered ones. Airplane engines that are quieter than those currently in use have been designed,

but no strong government mandate has encouraged their manufacture. Automobile and truck engines can be made quieter, and certain road surfaces can decrease traffic sounds. Snowmobiles that emit far less noise have been manufactured, but without legislation mandating their use, there is little demand. Consult the Internet for organizations working actively to require that quieter machines be in use. Write a report on the need for noise pollution equipment.

o Research the effects of snowmobiles, jet skis and all-terrain vehicles on wildlife. Contacting various organizations, including the National Parks and Conservation Association (see Organizations list in Teachers™ Aids section) for information on their work to keep these vehicles out of the national parks because of the negative effects the noise has on wildlife. Find out the decibel levels of various vehicles that are allowed in wildlife areas and off-road wilderness parks and their effects on various species of wildlife.

o The US Navy testing of anti-submarine sonar, Low Frequency Active Sonar (LFAS), described above, has been shown to be extremely dangerous to some marine mammals and drives others away from their traditional migration and feeding areas. Write the Animal Welfare Institute for more information on this program and how to help stop it.

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Films

The following represent only a few of the many films concerning animal calls and music. See the Video section of this book for further listings. Also, many audiocassettes are available with wildlife sounds of various types.

"Attenborough in Paradise." 1 hour. Nature (PBS). BBC. 1996.
David Attenborough visits New Guinea and describes the birds of paradise and

their extraordinary calls.
"Crane River." 1 hour. National Audubon Society. PBS Video. 1988. Hundreds of thousands of Sandhill Cranes migrate in the Midwest, bugling, calling and courtship displays, which resemble minuets.
"Gentle Giants of the Pacific: Humpback Whales" 1 hour. Sierra Club Series. Wood Knapp Video. The amazing songs of these whales are heard in this film.
"In the Company of Whales" 90 minutes. Discovery Channel. (VHS & CD•ROM.) 1992. Following great whales and hearing their sounds with zoologist Roger Payne and other experts, insights are given on whale behavior and biology.
"Jaguar. Year of the Cat." 1 hour. Nature (PBS). Telenova Productions. 1995. Filmed in the rainforests of Belize, the daily life of Jaguars is seen in remarkable close-ups accompanied by the sounds these cats make as they walk in the forest or lap water in a stream, with insect and bird songs in the background.
"National Audubon Society's Video Guides to North American Birds." Five one-hour cassettes. National Audubon Society. These videos show and record all species in the United States and Canada for which photo documentation exists. Audiocassettes of almost all the native breeding birds are available from this organization.
"Wild Wolves." 1 hour. BBC. NOVA. PBS. 1997. This film examines the true nature of wolves, their behavior and ecology and lets us listen to their howling.

Catalog of books and CDs with audio samples: www.earthear.com

Lawns

Project Summary

Many biologists and conservationists are now questioning the use of green lawns in yards, in front of public buildings and along highways. In general, green lawns have to be maintained through use of chemicals that can pollute the groundwater and kill beneficial plants and insects; use noisy, gas-guzzling mowers and leaf-blowers; and fail to preserve native plants. This project involves examination of the effects of these lawns on the environment and human health, as well as the use of energy and water to maintain them.

Background

Most biologists consider grass lawns to be ecological deserts because of their lack of diversity. In many areas, grass lawns cover a large percentage of land in villages and suburbs. Golf courses are increasing in number. Lawns are replacing natural habitats, such as woodlands, grasslands, shrub and desert and, in the process, wildlife and natural landscapes retreat. The Eastern Box Turtle has lost a large percentage of its original long grass, shrubby habitat to green lawns, and the species has declined dramatically. These slow-moving reptiles are also badly injured or killed by lawn mowers, which smash their shells (see Stevens 1994). Migratory birds and butterflies return in the spring to find their natural habitats converted to green lawns, depriving them of feeding and breeding sites. In general, lawns provide little or no habitat for wildlife.

To keep them green, herbicides, pesticides and chemical fertilizers are sprayed or spread in vast quantities. More than 67 million pounds of chemicals are placed on US lawns annually (see Wasowski 2001). These chemicals kill useful native animals, such as pollinating insects, birds that disperse seeds and consume insects, burrowing rodents, and earthworms that aerate the soil. They also contaminate the groundwater. Some of these poisons are so powerful that

they have caused sickness and death in humans. Early in 2001, the city of Halifax, Nova Scotia, Canada, became the first in North America to order a ban on all insecticides, herbicides and fungicides used on lawns. The ban was primarily intended to protect human health, especially children who are most vulnerable to pesticides (see Nickerson 2001). Fifty-five other communities across Canada are considering similar bans. Opposition to grass lawns and frequent mowing along public highways is also growing. One citizen of Orleans, Massachusetts, objected to the *The Boston Globe* when mowers destroyed carefully planted native wildflowers growing along a major highway in this Cape Cod area. The flowers, planted by volunteers (one as old as 85), of the New England Wild Flower Society, had been clearly posted not to be mowed.

Green lawns require constant care and use enormous amounts of energy for mowing, edging and removing leaves. Most lawn mowers and leaf blowers consume gasoline and pollute the air with fumes, while also creating noise pollution. Mowers also damage tree trunks or kill above-ground tree roots, especially of old trees, and frequently-applied fertilizer can harm older trees, which need slow-release enrichment of the soil (see Stocker 2001). For these reasons, gardeners recommend that no large tree be within 2 feet of a lawn. Another threat to trees is lawn watering during droughts; an insufficient amount of water reaches the tree roots, while the lawn absorbs most of the water (see Stocker 2001).

Lawns are also extremely costly. The American Nursery and Landscape Association estimated that Americans spent $17.4 billion on their lawns in 1999 (see Schembari 2001). The Lawn Institute, based in Illinois, estimates that the lawn care industry for North America is worth more than $25 billion (see Nickerson 2001). By planting perennial native grasses, shrubs, trees and flowers, homeowners could save literally billions of dollars.

The grass used for lawns in the United States is composed of various European turf species, which, unlike most native American grasses, require large amounts of water, often as much as a third of local water supplies. Householders use 40 to 60 percent of their water on their lawns in the summer. Erroneously called "Kentucky Blue Grass," this and other commercially distributed grass seed needs cool, damp climates for healthy growth. The grass quickly turns brown in the heat of summer or when not watered enough. In dry seasons, many towns mandate water rationing because lawn watering has depleted local supplies. The average lawn will use up to 10,000 gallons of water of a summer and 10 times the amount of pesticides as an acre of farmland (see Egan 2001).

Communities being built in dry areas, such as southwestern deserts, tend to plant green lawns because their owners have come from areas where they were typically used. In desert areas, green lawns can only be maintained through diversion of water that dries up rivers or alters the ecology of these regions. In Arizona, for example, several rivers have been reduced to dry beds by diversion for the burgeoning developments surrounding Phoenix and Tucson. Cities of the Southwest and California use enormous amounts of their water supplies to water green lawns. In the process, several pairs of endangered Bald Eagles that nested on one of these rivers, along with thousands of other forms of life, disappeared. One new resident of Phoenix, an architect, planted native plants in his garden instead of grass, defying local developers**,** who remove all native vegetation and cover the land with gravel. His yard was soon filled with wild marigolds, creosote bushes and other plants that seeded themselves in his beautiful, no-maintenance back yard. In Glendale, Arizona, homeowners receive a $100 rebate for converting 50 percent or more of their grass to shrubs or plants. Studies from Las Vegas found that a city could save 40 percent of its water by converting to non-grass alternatives. With the world facing increasing water shortages, the grass lawn, especially of non-native species of grasses, has become a luxury that is wasting this precious resource.

Green lawns can be grown with native grasses that do not require artificial watering and chemicals, and by using the cut grass as mulch. Fertilizers and herbicides are not necessary for these lawns, which can be mowed with electric or old-fashioned, human-powered mowers. Also, smaller areas can be planted. Instead of dominating the yard, lawns can become a minor part. Planting native vegetation, including wildflowers, shrubs and trees, in back yards and city lots is a preferable alternative to the green lawn. In shady, moist areas, mosses can be planted that never require mowing and stay green year-round (see reference list below). Perennial plants do not need replanting each year and require almost no maintenance. Trees provide shade, erosion control and habitat for wildlife. Planting a garden with

native American plants can also aid in the conservation of ecosystems and rare species. By not using chemicals, groundwater and wildlife are protected.

Activities

Consult the books listed below before beginning the following project:

o Select two small land plots (each about 200 square feet) each distanced from one another by at least 100 feet. Prior to planting, take samples of soil and examine them under a microscope to determine the diversity of plants and animals, whether there are earthworms to aerate the soil, and other life forms. Measure the acidity. Describe the soil's texture, whether rich loam, clay or sand, and whether it is dry and crumbly or moist. Are there birds that feed in the grass or evidence of small mammals, such as tunnels? In one half of the plot, plant non-native grass and use the chemicals recommended by the grass seed company. Water and mow the lawn, if needed. On the other half of the lawn, dig up the soil and spread natural compost from leaves and other vegetation throughout, to a level of 2 feet. Sow seeds of native grasses**,** such as buffalograss (sold in many nurseries). Water this portion until the seeds are established, but not afterward. Do not apply any artificial fertilizers or other chemicals. Mow with electric or hand mower only. After one month, take soil samples from both areas and examine them under a microscope to determine the diversity of microbes and the moisture content in the two soil samples. Note whether the organic wildlife area has above-ground evidence of wildlife such as butterflies, small mammals, reptiles, amphibians and birds. Identify them by species. Did the organic grass survive without artificial watering? Compare the two soils, their moisture content, invertebrate species diversity, water usage, environmental effects and the cost to maintain each one. A third alternative is described in the next project, fiLiving with Nature,fl focusing on conversion of the lawn to native wildflowers, bushes and trees, which requires even less water and labor.

o As a study project, select a suburban area of approximately one city block and measure the acreage in green lawns, calculating the cost in use of chemicals, as well as gasoline for lawn mowers and leaf blowers. Estimate water consumption and the percentage of this that must be artificially applied through hosing or sprinklers. What is the water source? Ask the local water department how much water is used in your area for watering lawns each year. Contact the Environmental Protection Agency in Washington, DC, for information on contamination of groundwater by lawn chemicals and their effects on wildlife and human health.

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Living with Nature

Project Summary

This project focuses on planting a garden with native plants and creating natural habitats that will attract wildlife and provide breeding and feeding areas for a wide variety of species. If an area for planting is not available, the principles of a natural garden can be learned. Also, the project discusses means of avoiding any lethal methods to control insects or animals with which one can come into contact in one's home or back yard, including Raccoons in garbage pails, deer munching shrubbery or moles burrowing in garden plots.

Background

The ecological problems presented by green lawns (see previous project) have brought many people to realize that many gardens and yards tend to reflect a lack of ecological knowledge and concern, and fail to preserve a natural environment and maintain wildlife habitat. This subject has resulted in many books and even garden magazine articles, but only a small minority of homeowners have abandoned the green lawn or reduced its size, making it a small part of one's yard rather than the dominant component. The long-term goal of converting lawns to natural environments is to provide wildlife with habitat it has lost in recent times, a period during which housing developments gobbled up millions of acres of woodland and pastures. Also, lack of tolerance for wildlife has increased, with homeowners moving into areas only recently converted to housing to be dismayed and often fearful when they find wildlife in the back yard. These animals were the original tenants of the land, and we are the invaders, but few homeowners seem to realize this fact and want nature to be tamed and non-invasive. Common sense approaches to this potential conflicts will be explored.

Activities

o Conversion of a yard from grass to natural vegetation can be done at once by digging up the entire lawn, excavating at least 2 feet to aerate and compost the soil, and replanting. A natural garden can also be planted gradually, plot by plot. The most important step is preparing the soil by enriching it with natural compost and organic fertilizers so that soil microorganisms and invertebrates, such as earthworms, can flourish and plants will have a better likelihood of surviving. Acidity testing is important to create a soil condition to which the type of plants used will adjust. Conifers, mountain laurel, rhododendron and related plants require high acidity, while grasslands and meadows tend to be more alkaline. Use no pesticides or artificial chemicals. Also to be avoided are bug zappers. These electric units that hang outside and electrocute insects have been shown to kill thousands of useful insects, such as moths, but almost no mosquitoes, for which they are intended (see *Wildlife Conservation* magazine, July/August 1997). A school class can utilize a plot of land of varying size according to the amount of time and effort it can expend. Many of the books listed below provide clear guidelines to follow in establishing a garden with native plants. Plan the garden to conform to the regional ecosystems, and use only plants native to the area. Some of the suggestions made in various books and articles include planting non-native plants to attract butterflies or birds. This should be avoided, and such plants should be removed. Consult guides to native plants to determine whether a species is indigenous. The best sources for native plants are organizations, such as the New England Wild Flower Society in Framingham, Massachusetts, that propagate all plants sold and recommend that no wild plants be dug up from woodlands or other natural habitats. The most coveted and delicate species, such as damp woodland trilliums and lady slippers, will almost surely die if transplanted from the wild, as they live in a symbiosis with fungi. Moreover, they require many years to mature and are rare in the wild. The habitat established--whether a woodland, small pond with water plants, prairie with wildflowers, desert landscape with cacti or marsh--should be compatible with local vegetation. It might consist of recreating a habitat destroyed by developers on the very site. If the lot is completely open without shade trees or even bushes, it is not possible to establish a woodland environment immediately. The planting will have to be transitional, using species that would naturally seed in such areas, such as birch and ground cover plants in northern and

mountainous areas. Whichever habitat is chosen, carefully record which plants are introduced and their survival on a regular basis.

o If you are creating a butterfly garden, follow instructions such as provided in the booklet, "Butterfly Gardening in New England," to establish shrub plants for the larvae, fragrant flowers to provide nectar for adults, a damp area for moisture and mineral feeding, and tangles of vegetation for the caterpillars. Keep in mind the locality. Host plants differ in each region of the country. In an open environment, a field of native goldenrod, milkweed and a diverse selection of plants would have the best likelihood of survival and attract butterflies of many species. Many butterflies specialize in a particular type of host plants, and only these can be planted. Flowers that attract many species of butterflies are a good introduction to such a project. When the flowers have appeared, spend an hour each sunny afternoon recording the species and numbers of butterflies that come to feed. Later in the season, try to find eggs, chrysalids and caterpillars among the vegetation. A good source for more information on this subject is *A World for Butterflies*. Photograph them. Note also other types of wildlife that come, whether birds, small rodents or other species. Write a report on the project, recording the successes and failures from beginning to end. The flowers may be left indefinitely, as they are perennials.

o Animals such as Raccoons, squirrels, deer, skunk, moles and rabbits are often seen as pests to be eliminated if they cause damage, eat prize plants or vegetables, or create burrows in the soil. What seems to be a major problem that can only result in trying to eliminate the animals can be solved or attitudes changed so that wildlife is better tolerated. *Living With Wildlife*, a book published by the Sierra Club, is based on the experiences of the California Center for Wildlife, a wildlife rehabilitation and education center with more than 200 volunteers and a professional staff. They receive more than 12,000 calls a year from people who have problems dealing with animal nuisances. Many problems, such as animals eating garden vegetables, can be solved with fencing, having garbage cans that cannot be opened by animals or are placed behind barriers, and spraying bushes and vegetation with substances and odors that repel animals. For example, to "raccoon-proof" a garbage can, fasten the lid securely with rope, bungee cords, chain or even weights. Secure the handle to a metal or wooden stake driven into the ground to prevent it from being rolled around. Store cans in wooden bins or in a locked shed or garage. Certain smells, such as ammonia, repel animals and can be sprayed on bushes or garbage cans. This book gives specific advice as well as encouraging a tolerant and positive attitude toward wildlife, reflecting the knowledge that we have entered *their* territory, not the opposite. If one's home has destroyed important habitat for wildlife, it is important to consider recreating it by allowing brush and shrubs to grow, instead of neat flower beds, to provide habitat for turtles, rabbits and groundhogs to share the property. Consider that a graceful deer in one's yard is a privilege to see. To protect special trees or fruit, spray them with repellants that contain milk, and hang bags of human hair. Most people choose to share their yards with deer and other wildlife, planting vegetation for them. It is also important to be tolerant of predators, such as bear, Cougar, Coyote and wolves, while staying far away from them. These predators, especially Cougar and Wolves, play an important role in regulating populations and maintaining the strength of deer and other ungulates. The overpopulation of deer in many parts of the country can be blamed on direct persecution of large predators. These predators should never be fed or approached, however, but allowed to exist as vital components in ecosystems. Few people are aware that Coyotes and foxes are important consumers of mice. A key factor in developing tolerance of wildlife is to understand their need to survive and to learn about and respect their natural behavior.

Books and Publications

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Lifestyles and Citizen Action

Through small changes in our lifestyle, we can reduce our use of energy, our pollution, our unnecessary consumption of material goods and help wildlife and the natural world. By launching programs within our community and making other contributions to conservation, we can have an even greater impact. This project will examine some examples of each conservation approach and encourage activism to preserve nature and endangered species. It will make recommendations about purchases that can either aid or damage the environment and wildlife.

Activism on the part of individuals and governments is crucial to reversing the trends that are extinguishing species and habitats at an unprecedented rate. The natural world is a place of beauty that provides a cornucopia of medicines, food and inspiration. The majority of scientific discoveries lie in the future. Preserving these treasures should be the most important goal of society. Future generations will not forgive us if we extinguish this precious heritage, upon which we depend for our very lives.

The majority of people on Earth are too occupied with survival to understand and act on the need to preserve species and natural environments, especially wilderness areas. Those people who can teach means of sustainable living without harming nature should become far more active to prevent further extinctions and erosions of natural ecosystems. On the whole, we have failed to treat the environment and our fellow creatures with the respect needed to prevent further losses to our natural heritage. Never before, however, have we known so much about the components and functioning of ecosystems, nor have we had the technology and the will with which to remedy past errors in order to live in harmony with the Earth.

Land Protection
Sustainable Living
Internet Solutions
Purchasing Power

Lifestyles and Citizen Action: Land Protection

Background

One can contribute to the preservation of biological diversity worldwide in many ways. Land protection is key to species' preservation. In foreign countries, biological diversity is at great risk, with extinctions occurring on a daily basis. Through support of international organizations, vital tracts of land can be purchased or the government convinced to designate them as national parks. In the United States, bogs, vernal ponds and other temporary wetlands, longleaf pine forests, old-growth cedar forests, tallgrass prairies and desert springs are some examples. They are vital to the survival of countless species, but receive little or no state or federal protection from destruction, and harbor many endangered species. Making a project of protecting a threatened habitat and/or species could spell the difference between survival and extinction for a particular plant or animal species, a very worthwhile project.

Activities

o Support organizations that specialize in setting aside land. This is key to saving the wildest, most pristine and important habitats before they are ruined. By obtaining issues of past magazines and press releases of organizations, such as The Nature Conservancy or Conservation International, learn what land they have protected that provided important habitat for endangered species and how they work to identify and protect biologically important areas in need of conservation. Help an organization that is raising money for land that harbors rare or endangered species in a foreign country. One class raised more than $100,000 to purchase a sizeable rainforest tract, teeming with beautiful tropical birds, in Costa Rica. Far less funds per acre are needed to acquire land in many countries where biodiversity is high than in the United States or Europe.

o On a local basis, a class could save an endangered species by helping to purchase its habitat. Information on a state-by-state basis on endangered species and habitats can be obtained from the Natural Heritage Programs connected with each Environment or Wildlife Department. These programs identify rare, endemic and declining species and their habitats, including those in need of protection. Also, national, state and local organizations and government departments can help in identifying land in need of protection. In some cases, an organization that specializes in a particular type of animal, such as frogs, cranes or turtles, will know of such areas and may already be raising money to purchase them. The class can choose an area in need of fund-raising and begin to aid in a fund-raising campaign. It would be more feasible to choose land that is not so expensive or large that many years would be needed to purchase it. The Nature Conservancy or another organization may be preserving the land. Another option is to launch a campaign to convince a town, state or federal agency to designate an area as protected. A field trip should be taken to the site, guided by a biologist familiar with the habitat--its plants and animals. Someone in the class could be designated to photograph the site, while others would take notes on what the guide says for a report and write letters to the editors of local newspapers. The site may preserve one or more endangered species, as well as an endangered habitat. Once successful, contact local newspapers to publicize the event, and write up the achievement in terms of how the goal was attained and what biological treasures were protected.

Lifestyles and Citizen Action: Sustainable Living

Background

A growing number of organizations are providing people around the world with alternatives to destroying forests and other natural habitats to clear land, obtain firewood or raise livestock. In tropical areas, land cleared of rainforest can be farmed for only a few years because of poor soil. Organizations are now helping these farmers survive in ecologically friendly ways through donation of solar cookers and heaters, aid in establishing small farms that utilize

bio-gas (methane obtained from manure and sewage), and promotion of self-sustaining farming methods that do not destroy the environment. In Madagascar, primatologist Patricia Wright protected the forest home of endangered lemurs by convincing the government to establish a large national park. It provided many jobs for local people. She then raised money for the construction of schools and clinics. Deforestation has virtually stopped as a result, and the people have become protective of the forest after learning how it prevented mudslides. Providing this type of help for people in poor areas of the world will be a major project of Conservation International, which plans to integrate this approach with its land protection and biodiversity studies, through a donation it received of more than $1 billion.

Activities

o Select one or more threatened habitats that are being destroyed as a result of over-grazing, deforestation or other means by people in developing countries. Many examples are given in the main text of this book. In classroom discussion, explore the ways in which these areas are being destroyed. What habitats and threatened species are disappearing as a result? What do you think should be done to prevent this situation from continuing and to help the people at the same time? For example, in Central Asia, so many sheep, yak, horses and other livestock are grazed by nomadic people that they are ruining the grasslands, leaving little food or habitat for native gazelles, wild camels, antelope and wild horses. Native predators, such as wolves, bears and Snow Leopards, are killed as potential threats to the livestock. Make specific suggestions that would provide for the basic needs of the people by alterations in their lifestyle and simple technology, while preserving the ecosystem.

o Consult the Internet and other sources for organizations that distribute solar cookers and simple technology, as well as agricultural advice. Contact them with suggestions for areas to donate that harbor many endangered species and habitats. Ask which countries are the recipients of this aid. Find out which parts of the world are not receiving international aid and, if these areas are environmentally threatened, suggest that they receive aid.

Lifestyles and Citizen Action: Internet Solutions

Background

Internet websites provide a new avenue to protect the planet through programs like "click-to-donate." Merely by clicking onto the Internet site, one activates funding for wilderness, endangered species and environmental protection from corporate pledges. EcologyFund (www.ecologyfund.com) is one such website that receives more than 100,000 visitors each month. In exchange for ad exposure, the fund donates sponsors' money to protect wilderness, plant trees and reduce pollution. Threatened wilderness land in the United States, Canada, Mexico, Africa, the Amazon Basin, Patagonia and Scotland has been preserved, and the fund claims to protect 187 square feet of land and save 2 pounds of carbon dioxide per visitor every day. Care2 (www.care2.com) also has a "click-to-donate" program focusing on endangered species and rainforest protection. One of its programs, "Race for Big Cats," has protected 16,000 square miles of key habitat for endangered Tigers, Jaguars and Snow Leopards, in conjunction with the Wildlife Conservation Society. In cooperation with the Nature Conservancy, Care2 has purchased large tracts of rainforest.

A related approach to preserving wildlife and funding conservation work consists of Internet sites that tune into live videocameras located in national parks or other natural areas, sending signals to satellites. Some websites are free, while others charge a small fee. Cameras set up in South African national parks (www.africam.com) focus on wild animal lairs, waterholes and other wildlife spots. They have generated large sums of needed money for the park system. In the United States, television cameras have been trained on Peregrine Falcon and Bald Eagle nests and transmitted to a cable station that plays the picture. Solar-powered videocameras have been designed that can be placed in the most remote wilderness with no need for batteries or outside electric power sources. This concept has great educational potential, simultaneously raising money for endangered species and wilderness protection, while educating as well. Such websites can provide important information on these subjects while providing exciting views of wildlife and wild places. As an alternative to eco-travel for those of lesser means or those unable to travel, such

websites could offer tours, such as tree-top views of rainforests and their abundant wildlife, or close-ups of seabird colonies or coral reefs. They have the added benefit of protecting delicate ecological areas from the effects of too many tourists. Such websites should provide a portion of the funds to local people as an incentive to preserve the land and wildlife. If significant funds were generated, countries faced with choices such as whether to allow corporate logging, commercialization of wildlife, dams and other projects needed to repay national debts, might consider these cameras to be a better alternative. If successful, such websites would encourage countries to maintain large areas of wilderness. Videocameras also have a scientific potential in giving a 24-hour view of areas harboring wildlife, often difficult to observe through other means.

Activities

o Click onto several videocamera sites to see the various types of wildlife spectacles offered. Some examples: seemorebears.com (Alaskan bears feeding on salmon in season); www.african.com (see above); www.world-stream.com (views of ancient species of fish, the Coelacanth); zooatlanta.org (Giant Pandas). What threatened species or habitat would you like to see on a videocamera placed in the wild? Would you also like the views to be part of a menu offering information on the species and the habitat? What ideas do you have about the applications and potentials of these live videocams linked to the Internet and television cameras broadcasting to cable television stations?

o Select a country that is suffering high levels of environmental destruction
but also has beautiful scenery and many endangered species. Discuss the potential of proposing alternatives to such a country, i.e. placing videocameras as income producers versus commercial logging, a short-term destruction versus a long-term investment. What scenery and wildlife would you think would attract Internet users in this country?

Lifestyles and Citizen Action: Purchasing Power

Background

Developed countries consume 80 percent of the world's natural resources. If not for consumers in these countries, no market would exist for many luxury products, such as mahogany, teak and rosewood. The deforestation taking place to harvest these woods pushes many species of animals closer to extinction. Loggers take the largest and oldest trees. These are the ones most valuable as wildlife habitat, oxygen producers, carbon dioxide absorbers, soil stabilizers and water retainers. In spite of some programs meant to encourage "green" forestry practices, even selective logging, in which only a few trees are taken per acre, all types of logging have negative effects on pristine old-growth forests and their wildlife. (See Forests chapter). Many species are directly endangered through loss of habitat and hunting. People enter previously impassable forest on logging roads to kill Gorillas, chimpanzees, elephants, rare antelopes, birds and other wildlife for bushmeat markets and animal products for Traditional Medicine. (See Forests chapter). Old-growth forests in some parts of the world have been growing undisturbed, harboring the same types of trees for hundreds of millions of years. These forests are irreplaceable repositories of biodiversity and living pharmacies, precious for their scientific value as extraordinarily rich ecosystems. Scientific knowledge of the functioning of these forests and an inventory of their species has only just begun. Cutting one tree can kill a dozen that come crashing down as jungle vines entwine whole groups of trees and branches that stretch for long distances knock down neighboring trees. In the process, many animals lose their lives and habitats. Nest holes for birds, mammals, reptiles and insects, loose bark under which forest bats roost, tall canopies for eagles' nests--all are lost. The logs obtained are not essential for human survival, but are sold as raw material for coffee tables, wall paneling and lawn furniture for the wealthy. Thousands are cut merely to manufacture shipping cartons or chopsticks, used once and discarded. more than 80 percent of these old-growth rainforests have been logged in the last century, greatly reducing the production of oxygen, water vapor and absorption of carbon dioxide. Certain products, such as Brazil and cashew nuts, can be extracted from tropical forests without harm. Ecotourism has great potential as a means of income. If profits are shared with the people who gather them, they will have an incentive to protect these trees. Other products that

damage forests, especially tropical forests, are wooden carved boxes and tourist knick-knacks made from scarce woodlands in India, Indonesia and other countries where forests have been decimated.

Coffee was once grown in the shade of tall forest trees, but with the development of new strains of coffee plants, forests are being cleared to grow coffee in the sun (see the Forests chapter). Coffee grown in the shade is far more ecologically-friendly, since large trees are preserved. Many North American birds migrate to the tropics and winter in coffee plantations. The sun-grown coffee has deprived wildlife of this habitat. A campaign to return to shade-grown coffee, especially if grown without pesticides, was launched by the Smithsonian Institution a few years ago. Some commercial importers have provided a market for this shade-grown coffee, enlisting coffee farmers in many parts of the world to protect forests and grow coffee as an understory. Now this coffee is available in many US stores, marketed as "Shade-grown," "Bird-friendly" or "Shade-grown--Organic." Many of these coffees are comparable in price to, or only slightly higher than, sun-grown commercial coffee grown using pesticides. They have the added advantage of being healthier, since they contain no dangerous chemicals. Likewise, most bananas are grown with massive amounts of pesticides and herbicides, but many growers are now producing bananas organically. Ask your local grocery store to stock them and be aware that purchasing them helps the environment. A similar problem exists with the growing of chocolate from the cacao plant in tropical areas. Its great popularity in the United States has encouraged the clearance of forests for large-scale plantations that grow the plants in the sun, using fertilizer, fungicides and pesticides (see Khamsi 2001). Diseases have broken out in the large plantations, requiring heavy use of pesticides, fungicides and other chemicals to control them. Organic Commodity Products (OCP), a supplier in Cambridge, Massachusetts, promotes the growing of cacao in shade without artificial chemicals. Fortunately, 85 percent of the world's cacao is shade-grown. Some 6million small farmers who cannot afford pesticides provide this crop. Several chocolate companies are now marketing organic chocolate to promote environmentally friendly agriculture (see Khamsi 2001).

Caviar from sturgeon native to Russia and the Caspian Sea is one of the most valuable wildlife products. Sales in the United States and other importing countries have pushed virtually all Eurasian sturgeon species close to extinction. Even famous French chefs, including Jacques Pepin, recommend a boycott of Beluga, the most valuable caviar, which comes from the most endangered sturgeon species. Many other fisheries products come from species that have declined 90 percent or more in the past decade from overfishing. Atlantic Cod, Orange Roughy, Chilean Bass, Atlantic Bluefin Tuna, sharks of many species and swordfish have been seriously overfished. Many of these fish, such as sharks, are slow-reproducing, not having young until they are as old as 20 years. It is likely that their populations will never be able to sustain a commercial take. Pollack is a white fish from Alaskan waters that is being overfished to manufacture artificial crabmeat. The pollack fishery endangers Steller's Sea Lions, depriving them of a major food source. Shrimp from the Gulf of Mexico and many other tropical areas endanger sea turtles, which drown by the thousands in shrimp nets, which also catch millions of tons of unwanted fish that are discarded. Some shrimp is caught using nets that allow sea turtles and other non-target species to escape the net through turtle excluders, and these shrimp are often labeled "turtle-safe." Farmed shrimp and salmon involve environmental destruction. Mangroves are being cut in tropical countries around the world to construct shrimp farms, which emit large amounts of pollution. Farmed salmon are kept in off-shore pens, but many escape to breed with wild salmon, endangering the latter. The pens also contribute large amounts of pollution to the ocean.

Likewise, mining operations devastate entire ecosystems to obtain gold for jewelry and other minerals. The United States provides an enormous market for gold, the majority of which is made into jewelry. Even national parks in Indonesia are now permanently scarred, with large areas of land and rivers devegetated and poisoned with cyanide, which is used to separate the gold from ore. This country has the highest number of threatened species in the world, a majority of which are found only here. Orangutans are being driven from their forest homes in Indonesian Borneo and Sumatra by loggers and gold miners, their populations now facing extinction in the wild. It is such activities that are fostered by the market for gold. Diamond extraction can destroy wildlife habitat and river bottoms, as well as causing human rights violations when used as currency by dictatorial governments who torture their citizens. Pearl cultivation damages American aquatic ecosystems. Pieces of mussel shell are inserted into living oysters, which causes the oyster to exude pearl material to surround the mussel shell. The mussel shells used for this cultivation

come, for the most part, from the United States. Millions of tons of these shells are dug out of riverbeds, threatening some species.

As discussed in the Trade chapter and the previous project, millions of wild animals are captured for the pet trade and specialty collectors in wealthy countries. Parrots, cockatoos, macaws, turtles, tropical fish, snakes, lizards--and even frogs--are plucked from their tropical homes to be sold in pet stores. Some species have been driven to the edge of extinction by the wild pet trade, which also treats these animals inhumanely. The United States bans the import of most wild birds, but many species are still permitted under the Wild Bird Conservation Act. Also smuggling, a multi-billion dollar activity, funnels thousands of animals into pet stores where they are represented as legally taken or even captive-bred. Only 10 percent of shipments entering the United States are inspected for wildlife. For the majority of wild animals in the pet trade, little protection exists. Although the US Endangered Species Act and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) have helped limit trade, strict controls exist for only a small minority of the most endangered species. Since the United States is the world's largest wildlife importer, the effect on wildlife has been catastrophic.

Lizard, snake and crocodile handbags, shoes and luggage; ivory; feathers and other wildlife products are part of a trade that has endangered hundreds of species. Even if the product was not made from an animal on the US Endangered
Species List, it may be threatened by trade or inhumanely captured or killed. At present, for example, the reptile product trade is killing millions of snakes and lizards for leather products, causing many species to become threatened. Yet almost no controls have been placed on the trade, and what controls there are contain loopholes making them ineffective.

Many plants are endangered by harvesting for collectors. Rare cacti, delicate woodland and wetland species such as Venus Flytraps, Yellow Lady Slippers and other orchids, South African protea and a long list of other plants are being plundered in the wild. Many of these plants cannot be raised in captivity and have been illegally dug up in the wild.

Activities

o Write a report on the effects that American consumers have on old-growth tropical rainforests and their wildlife.

o Ask local stores if they carry shade-grown and organic coffees and, if not, would they stock them? Several grocery store chains and many health food stores sell these coffees. In restaurants and coffeehouses where coffee is served in large quantities, ask them to purchase at least a portion of their coffee as shade-grown, organic. Write the Smithsonian Institution's Ornithology Department for more information on the effect of sun-grown coffee on birds and other wildlife, and write a report on the subject.

o Select one of the jewelry materials mentioned, such as gold. Read the Forests chapter in this book and other references to the mining of gold in South America, Africa and Asia and its effect on the environment and wildlife. Write a short report on the mining operations in a particular country and their effects on wildlife and the environment. If purchasing jewelry, choose artificial diamonds, pearls and gold. These items can hardly be distinguished from the genuine ones because of advances in simulation technology. Other types of gem and metal mining also damage the environment.

o Discuss the general reasons for boycotting wild pets; fur coats; reptile products; feathers; caviar; threatened fish; turtle meat;, Traditional Medicine remedies made from wild animals, such as snakes, bear, seahorses and other animals; other wildlife products and rare plants that you have seen in stores. Select one species (or group of species, such as sharks) and write a report on how the trade is threatening it and how to publicize the need to boycott its products.

Books and Publications

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Films

"Affluenza." America's materialism affects the world's environment, destroying forests and other environments. Solutions to the out-of-control consumerism are offered in "Escape from Affluenza."
"Cultivating Opportunity. Self-Help Solutions to Poverty in the U.S. and Africa" focuses on small-scale farmers forming cooperatives to protect themselves against corporations taking over their land.
"Mountains of Gold" tells the story of Brazil's gold rush and the thousands of prospectors who pan and dredge gold in the rainforest.
"Secrets of the Choco" explores the survival of the Choco tribe in Colombia and its rainforest, threatened by highways and non-sustainable development. Six world experts on tropical ecology and sustainable development discuss the region's future.
"Super-Companies" concerns the operations of multinational corporations in terms of raw materials and how they are affecting the needs of people and the global environment.

Endangered Species Handbook

Teachers' Aids and Educational Materials:

Teachers' Aids

Internet

Organizations

Laughing Owl
(Sceloglaux albifacies)
Last Record: July 1914
© 2001/Peter Schouten

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Teachers' Aids and Educational Materials

Teachers' Aids
The American Biology Teacher. Published by the National Association of Biology Teachers, 12030 Sunrise Valley Dr., Reston, VA 20191; www.nabt.org; Phone: 1-800-406-0775. Although not primarily concerned with endangered species, this magazine occasionally has information on this subject.

Bullfrog Films™ catalog includes an extensive collection of educational films on the environment and wildlife, many of which are thought provoking and could serve as the basis for discussion. The catalog lists recommended grade levels and awards, accreditation and other background information on each film along with descriptions of the content. Some of the films are reviewed in the video section. www.bullfrogfilms.com; Phone: 1-800-543-3764.

Discovery Channel School. fiDiscovery Channel School K-12 Catalogfl lists materials, such as CD-ROMs and videos, which are packaged together. For example, the Insects packet includes a CD-ROM, a student resource book, fiInsect Files,fl a Teachers™ A-Z Resource Guide on Insects, and an Internet site featuring electron microscope images of insects and fiB-Eye: The World Through the Eyes of a Beefl to show what a flower looks like to a bee. Other packets with CD-ROMs, teachers™ guides and student resource books include: fiPlants,fl fiReptiles,fl fiFish and Amphibians,fl fiInvertebrates,fl fiProtists and Fungi,fl fi Mammals,fl fiBirds,fl fiEvolutionfl and fiEcology.fl The latter title™s Internet link features suggestions on projects to save beaches, a global warming debate about coral reefs, and fiEarth Today.fl Each CD-ROM contains a long video as well as library searches of references, a digital lab and instructions for presentations of slides, text and sound effects to be created by the students. Among the selections in the fiEarth Sciencefl CD-ROM bundle is fiConservation of Natural Resources.fl The latter CD-ROM is also offered in a bundle along with a student resource book, a teacher™s guide and Internet links. Videos geared toward school classes have themes divided into segments. Titles for grades 6 to 12 include: fiFinite Oceansfl on the limits of oceans to absorb pollutants and provide resources; fiCoral Reefsfl explores the Red Sea, an extremely diverse coral ecosystem; fiUnderstanding Oceansfl explains their movements, tides, endangered creatures and experts; fiWater: To the Last Dropfl investigates the contamination and misuse that threatens the limited supplies of freshwater upon which we depend; www.discoveryschool.com.

Conserving Earth™s Biodiversity by Edward O. Wilson and Dan L. Perlman, 1999. Island Press, Covelo, CA (interactive CD-ROM teaching conservation biology and environmental science). Teachers can register for an examination copy and view a demo at: www.islandpress.org/wilsoncd. Senior author is Harvard University professor, author of *The Diversity of Life* and editor of *Biodiversity*, key books on the subject.

Earthwatch. This bimonthly periodical, published by Earthwatch, is available by subscription and is sold by many newsstands. Earthwatch sponsors research projects by scientists. Contributors, scholarship and fellowship students may accompany scientists on their expeditions. Projects have included studies of threatened plants and animals and their disappearing habitats in Australia, Brazil and Thailand; endangered sea turtle ecology in Baja California, Mexico; and Florida Manatees. A typical project is carried out by a scientist affiliated with a well-known university or institution. Volunteers pay to assist the scientists by making observations, taking photographs and performing miscellaneous duties for a period of about two weeks. Active participation in the study depends on the health, interests and abilities of the volunteer. Many teachers go on expeditions, taking copious notes and photos, and use the experience as a teaching outline for courses. Students may also be sponsored by their class or family. Volunteers must

be 16 years or older. For those unable to participate in research trips, project briefings are available for $15 each, written by the scientists heading each project, with background information and results as available. There are scholarships and fellowships offered to selected applicants. Earthwatch Institute, 3 Clock Tower Place, Suite 100, P.O. Box 75, Maynard, MA 01754-9928; Phone: 1-800-776-0188; www.earthwatch.org has more than 5,000 pages of background information on projects, a global classroom, an education site, and a virtual expedition. The site has won more than 25 awards for excellence.

Endangered Means There™s Still Time This free US Fish and Wildlife Service brochure explains the basic causes endangering species. The brochures, fiPlacing Animals and Plants on the List of Endangered and Threatened Speciesfl and fiESA Basicsfl explain the listing process, critical habitat and other facets of the US Endangered Species Act. fiWhy Save Endangered Species?fl presents strong arguments for the preservation of biodiversity as it benefits human health and agriculture and tells how animals can be barometers of environmental quality, warning us of the dangers of pesticides, for example. Other brochures include profiles of the Mexican Wolf, Red Wolf, Whooping Crane and others. fiConserving Borderline Species, A Partnership between the United States and Canadafl is a report describing the cooperative programs that have helped Whooping Cranes, Swift Foxes, Black-footed Ferrets and other wildlife and plants that inhabit both sides of the Canada/US border region. A poster entitled fiThe Road to Recoveryfl illustrates some of the species that, because of the Endangered Species Act, have increased in numbers from Near-extinction: the Grizzly Bear, Bald Eagle, Lange™s Metalmark Butterfly, Gray Whale and Greenback Cutthroat Trout. By calling the Publications Unit of the US Fish and Wildlife Service (304-876-7203) or the Office of Endangered Species, one can also request fact sheets on a selected number of US endangered species and copies of US Fish and Wildlife Service publications (USFWS, 4401 N. Fairfax Dr., Arlington, VA 22203; www.fws.gov/). Further information on US endangered species is available from www.natureserve.org, a private database providing legal status and general information on all species listed by The Nature Conservancy as Imperiled.

Environmental Vacations: Volunteer Projects to Save the Planet, by Stephanie Ocko, 2nd edition, John Muir Publications, 1992. Distributed by W.W. Norton & Co., 248 pages. This book describes ways in which nonscientists can assist experts in activities (such as monitoring the diversity of rainforests), observing animal behavior or other projects, giving particulars on the projects and how to become involved.

The Globe program for classrooms involves students from around the world who participate in ecology studies by gathering and analyzing data; ncdc.noaa.gov/GLOBE/globe.html. It is affiliated with the National Oceanic and Atmospheric Administration (NOAA).

Green Teacher, P.O. Box 1431, Lewiston, NY 14092; or in Canada, 95 Robert St., Toronto, Ontario M5S 2K5, Canada. Five issues per year, $27.00; sold on newsstands also. This magazine is very well done. It lists environmental projects and activities and has a humane orientation. Some articles are in both French and English.

Knowledge Unlimited, P.O. Box 52, Madison, WI 53701-0052; www.ku.com. This catalog lists videos, filmstrips, resource guides, classroom posters, books and other educational materials under major categories, including Science, which has many listings on endangered species and environmental topics.

National Geographic Society. The Educational Services department of the National Geographic Society provides material, films and filmstrips on general science and biology, including endangered species and habitats. Its free catalog, fiSchool Publishing,fl for Grades K-12 offers a wide variety of environmental books, videos, CD-ROMs and

other visual material accompanied by teachers™ guides. An Internet site designed for teachers gives further detail: www.nationalgeographic.com/education. One learning packet centers on the Tiger. The teaching guide includes lessons on habitat, populations, adaptation, predator/prey relationships, conservation and scientific studies, accompanied by two videos the society produced on the species, slides, posters and student handouts. Another teaching unit describes The Jason Project Expeditions, sponsored in part by the National Geographic Society. Each centers on a part of the world. These kits combine studies of a variety of disciplines centered on an area or country: biology, climate study, geology and others.

Students learn how to measure pollutants and study endangered species™ diets. These lessons are also shown on the new National Geographic television channel. An interactive encyclopedia CD-ROM on Mammals, for Grades 2-12, allows students to see and hear more than 200 mammals through photos, range maps, acoustics, facts on endangered species, mystery games that test powers of deduction, and a lesson plan booklet. Videos made for the classroom on many subjects include a series on bioscience, showing life cycles of various insects, a trout river ecosystem, and other themes for various grade levels. Each includes a teacher™s guide and is described in the Teacher Store page or in the Video and Media Catalog. Anatomy of frogs and other animals are included in material that teaches function, taxonomy and structure. For the growing number of teachers and students who would rather find another means of learning about frog or mammal anatomy rather than dissection, especially in view of the declining status of frogs, this material provides a solution. (Also see the Projects Section in this book, fiLearning Animal Anatomy Without Dissection.fl)

*Rainforest Teacher™s Packet.*Rainforest Action Network, 221 Pine St., Suite 500, San Francisco, CA 94104. Educational materials listed on www.ran.org; Phone: 415-398-4404. Students and others may sign up for fiaction alertsfl on issues affecting the world™s rainforests.

The Rainforest Book. How you can save the world™s rainforests, by Scott Lewis with the Natural Resources Defense Council, Living Planet Press, 1990. Aimed toward students, the text has chapters on the importance of rainforests, both tropical and US temperate rainforests, how they can be saved and how individuals can help with specific examples of aiding organizations, encouraging local businesses not to buy rainforest products, visiting rainforests, adopting an acre of rainforest, and further reading, films and other information sources.

Save America™s Forest. Citizen Action Guide The activist organization, Save America™s Forests, has published a 51-page how-to guide for citizens and/or students to work within communities to educate others on the decline of America™s forests from clearcutting and over-harvesting. It is available online at www.saveamericasforestsfund.org. Also available from this organization, a slide show, fiClearcuts Coast to Coastfl (purchase or rental); an annotated bibliography on forests; and the award-winning video, fiThe Last Ancient Forestsfl (11 minutes, purchase $7). Save America™s Forests, 4 Library Ct., SE, Washington, DC 20003; www.saveamericasforests.org; Phone: 202-544-9219.

Science Teacher. National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201-3000; Phone: 703-243-7100; www.nsta.org. Published nine times a year, this is a valuable periodical, aiding teachers of environmental subjects.

Teacher™s Guide to World Resources and Biodiversity(ISBN 0-7872-4259-4), 2001. This guide provides economic, ecological, ethical and esthetic reasons why we should care that species are becoming extinct. Students explore the root causes of biodiversity loss and strategies for conservation. Cost is $9.99. Published and distributed by Kendall Hunt, it can be ordered online through their Web site. The site also includes fiEndangered Forestsfl and many other

titles on the environment. Discounts are given to teachers who order in bulk. Web site: www.kendallhunt.com; Phone: 1-800-542-6657.

fiUnderstanding Biodiversity.fl Encyclopedia Britannica™s 19-minute video is aimed at high school students. It stresses the need for ecosystems to have diverse life forms and the important roles different types of scientists play in biodiversity preservation. The cloud forests of Venezuela are the background for teaching this subject. A Teacher™s Guide is included, listing objectives and suggestions for classroom discussion topics. Encyclopedia Britannica Educational Corporation (1-800-554-9862).

fiBritannica. Electronic Media Catalogfl descries many videos (without teachers™ guides) on the environment and wildlife. It also offers a fiGuide to Dissection,fl in which a video software package with four parts shows dissections of a rat, frog, pigeon and dogfish. Using software, the student can do a virtual dissection with a computer mouse.

Video Project. Free catalog of educational environmental videos for use in schools and libraries. Video Project, P.O. Box 77188, San Francisco, CA 94107; Phone: 1-800-4-PLANET; www.videoproject.net.

The Wild Ones. The Wildlife Trust (formerly the Wildlife Preservation Trust) is a sister organization to the Durrell Conservation Trust in the United States, founded by Gerald Durrell, noted author and conservationist, which works on environmental and endangered species programs throughout the world. For students, the organization sponsors fiThe Wild Onesfl (www.thewildones.org), which includes a newsletter, *The Wild Ones*, and accompanying fiTeacher Connection,fl both of which can be downloaded from its Web site. The latter enrolls classes and provides suggestions for curriculum activities involving conservation, endangered species, natural history and related topics that complement the newsletter. *The Wild Ones* is also published in other countries, such as Mexico, translated into Spanish, with added topics pertaining to that country™s environment and wildlife.

Letters and artwork from students around the world are published on the site. Through the Web site, students can write the scientists working on various projects for the organization. The newsletter for the general membership, *On the Edge*, often focuses on particular endangered species; recent issues may be accessed through the Web site under fiField Notes,fl with the year of publication. The organization in the United Kingdom, which publishes the newsletter *The Dodo Dispatch* (ages 7-16), and the Canadian sister organization can be reached through the Web site as well. The Wildlife Trust, 61 Route 9W, Palisades, NY 10964-8000; Phone: 845-365-8337; www.wildlifetrust.org.

Wildlife Review Abstracts, National Information Services Corporation, 3100 St. Paul St., Suite 806, Baltimore, MD 21218. Formerly a quarterly report published by the US Fish and Wildlife Service, these annotated bibliographies are now a privately run database system with 514,000 entries of publications on wildlife and the environment, indexed by species, subject and geographical areas. Abstracts from wildlife, fisheries, ornithological, ecological and forestry journals are sold through a yearly subscription for $1,045. The data is available on CD-ROM and is compiled from many sources. The Wildlife Species Information Library at the site includes data on habitats in states from a DOS-based CD-ROM or 45,000 pages of online species™ profiles. Phone: 410-243-0797; www.nisc.com.

Internet
All Endangered Species:

IUCN Red List of Threatened Species: www.redlist.org/
FWS Endangered Species Program: www.fws.gov/endangered/
WWF Wildfinder: www.worldwildlife.org/wildfinder/

Bats:
Bat Conservation International: www.batcon.org
www.bahnhof.se/~pettersson (identifying bats by their sound waves)
Swedish Bat Detector company: www.batsound.com.

Bears:
Nature Net: www.naturenet.com/bears/.
Discovering Lewis & Clark: www.lewis-clark.org.
Yellowstone National Park: www.yellowstone-natl-park.com/bearstor.htm.
Great Bear Foundation: www.greatbear.org.

Birds:
The Peregrine Fund: www.peregrinefund.org
(California Condor and other reintroduced endangered birds of prey).
Warbler Watch of Cornell Laboratory of Ornithology and National Audubon Society: birdsource.cornell.edu.
US Fish and Wildlife Service, endangered species breeding center at Patuxent Wildlife Research Center: mbr-pwrc.usgs.gov/bbs/ident.html.
Peterson Multimedia Guides: (sightings of rare birds): www.petersononline.com.
The Raptor Center, University of Minnesota (tracks Ospreys in their winter migration): www.raptor.cvm.umn.edu.

Butterflies:
Bugbios: insects.org/ced4/symbol_list3.html.
Journey North: learner.org/jnorth/current.html (tracing Monarch Butterfly migrations to Mexico, with classroom participation in the United States and Mexico).
Cornell Center for the Environment: www.cfe.cornell.edu (projects to monitor butterfly populations).
A World for Butterflies: www.aworldforbutterflies.com (Dr. Philip Shappert, editor of *News of the Lepidopterists™ Society* and author of *A World for Butterflies*).

Marine Species:
Sea Turtle Survival League: www.cccturtle.org (sea turtle tracking with satellite transmitters).
The Karen Beasley Sea Turtle Rescue and Rehabilitation Center: www.seaturtlehospital.org (hospital for injured and sick sea turtles, many with shattered shells from boat collisions and infections from pollution during nesting season, volunteers protect 100 nests and hatchlings).
University of Maine™s Lobster Institute: www.lobster.um.maine.edu/lobster
(live video of lobsters in the wild).
SeaWeb: www.seaweb.org (marine education).
Ocean Planet, The Smithsonian Institution: seawifs.gsfc.nasa.gov/oceanplanet.html
(traveling exhibits with links to background material).
Woods Hole Oceanographic Institution: www.whoi.edu
(research projects and access to its library and oceanographic sites).
Mote Marine Laboratory: www.marinelab.sarasota.fl.us
(information about red tides and sea turtle rehabilitation).
SeaWatch: www.seawatch.org or www.seawatchfoundation.org.uk.

Wolves and Wild Dogs:
NOVA/PBS: www.pbs.org/wgbh/nova/wolves.
Penn State College of Earth and Mineral Sciences: www.ems.psu.edu.

Yellowstone Wolf Report: yellowstone-natl-park.com/wolf.html.
Wolf Haven International: www.wolfhaven.org.
Wolf Education and Research Center: www.wolfcenter.org.
Defenders of Wildlife wolf program: www.defenders.org.

Timber Wolf Information Network: www.timberwolfinformation.org.
Wild Canid Survival and Research Center: www.wolfsanctuary.org.
The Association for Nature fiWolffl: www.most.org.pl/wolf
(Godziszka, Poland; wolves in Poland and Europe).
International Wolf Center: www.wolf.org.
Dhole home page: www.cuon.net/dholes (information on the Asiatic wild dog, its biology, research and conservation).

Organizations

A Œ B Œ C Œ D Œ E Œ F Œ G Œ H Œ I Œ J - K - L - M

N Œ O Œ P Œ Q Œ R Œ S Œ T Œ U Œ V Œ W Œ X Œ Y - Z

Organizations: A

African Wildlife Foundation, 1400 - 16th St., NW, Suite 120, Washington, DC 20036; Phone: 202-939-3333; http://www.awf.org/. Quarterly magazine, *African Wildlife News*.

Alaska Wildlife Alliance, P.O. Box 202022, Anchorage, AK 99520-2022; Phone: 907-277-0897; http://www.akwildlife.org/.

Alliance for the Wild Rockies, P.O. Box 8731, Missoula, MT 59807; Phone: 406-721-5420; http://www.wildrockiesalliance.org/.

Amazon Conservation Team, 4211 N. Fairfax Dr., Arlington, VA 22203; Phone: 703-522-4684; http://www.ethnobotany.org/.

American Anti-Vivisection Society, 801 Old York Rd., #204, Jenkintown, PA 19046-1685; Phone: 215-887-0816; http://www.aavs.org/.

American Association of Botanical Gardens and Arboreta, 351 Longwood Road, Kennett Square, PA 19348; Phone: 610-925-2500; http://www.aabga.org/.

American Association of Wildlife Veterinarians: http://www.aawv.net/.

American Bird Conservancy, P.O. Box 249, The Plains, VA 20198; Phone: 540-253-5780; http://www.abcbirds.org/

American Birding Association, P.O. Box 6599, Colorado Springs, CO 80934; Phone: 719-578-1480; http://www.americanbirding.org/.

American Cetacean Society, P.O. Box 1391, San Pedro, CA 90733-0391; Phone: 310-548-6279; http://www.acsonline.org/.

American Chestnut Foundation, 469 Main St., P.O. Box 4044, Bennington, VT, 05201-4044; Phone: 802-447-0110; http://chestnut.acf.org/.

American Fisheries Society, 5410 Grosvenor Ln., Bethesda, MD 20814; Phone: 301-897-8616; http://www.fisheries.org/.

American Forests, P.O. Box 2000, Washington, DC 20013; Phone: 202-955-4500; http://www.amfor.org/.

American Fund for Alternatives to Animal Research, 175 West 79th St., Suite 16-G, New York, NY 10011; Phone: 212-989-8073; http://www.uiowa.edu/~vpr/research/animalt.htm.

American Museum of Natural History, Central Park West at 79th St., New York, NY 10024-5192; Phone: 212-769-5606; http://www.amnh.org/. *Natural History*, 10 issues/year.

American Oceans Campaign, 600 Pennsylvania Ave., SE, Suite 210, Washington, DC 20003; Phone: 202-544-3526; http://www.americanoceans.org/.

American Ornithologists™ Union, Museum of Natural History, 10th and Constitution, NW, #116, Washington, DC 20560; Phone: 202-357-2051; http://www.aou.org/.

American Rivers, 1025 Vermont Ave., NW, Suite 720, Washington, DC 20005; Phone: 202-347-7550; http://www.americanrivers.org/.

American Society for the Prevention of Cruelty to Animals (ASPCA), 424 East 92nd St., New York, NY 10128; Phone: 212-876-7700; http://www.aspca.org/. Quarterly magazine, *ASPCA Animal Watch*.

American Society of Mammalogists: http://www.mammalsociety.org/.

American Veterinary Medical Association, 1931 N. Meacham Rd., Suite 100, Schaumburg, IL 60173; Phone: 847-925-8070; http://www.avma.org/.

American Zoo and Aquarium Association, Oglesbay Park, Wheeling, WV 26003; Phone: 304-242-2160; http://www.aza.org/.

Amigos del Bosque, Mr. Noe Adalberto Ventura Loyo, 9a Calle 2-23 zona 1, 01001 Guatemala City, Guatemala; Phone: 502-2-21-14-40. Rainforest protection organization.

Ancient Forests International, P.O. Box 1850, Redway, CA 95560; Phone: 707-923-4475; http://www.ancientforests.org/. *News of Old Growth* newsletter.

Animal Legal Defense Fund, 127 Fourth St., Petaluma, CA 94952; Phone: 707-769-7771; http://www.aldf.org/.

Animal Protection Institute, P.O. Box 22505, Sacramento, CA 95822; Phone: 916-447-3085; http://www.api4animals.org/.

Animal Welfare Information Center, US Department of Agriculture, Agricultural Research Service, National Agricultural Library, 10301 Baltimore Ave., 4th Fl., Beltsville, MD 20705-2351; Phone: 301-504-6212; http://www.nal.usda.gov/awic.

Animal Welfare Institute, 900 Pennsylvania Avenue, SE, Washington DC 20003; Phone: 202-337-2332; http://www.awionline.org/. *AWI Quarterly* newsletter; reports and educational materials.

Animals™ Agenda, The, P.O. Box 25881, Baltimore, MD 21224; Phone: 410-675-4566; http://www.animalsagenda.org/.

Ark Trust, Inc., P.O. Box 8191, Universal City, CA 91618-8191; Phone: 818-501-2ARK; http://www.arktrust.org/. Presents Genesis Awards to members of media for films and television programs that promote animal conservation and humane treatment.

Association for Nature fiWolf,fl ul. Gorska 69, 43-376 Godziska, Poland; http://www.most.org.pl/wolf.

Association of Veterinarians for Animal Rights, P.O. Box 208, Davis, CA 95617-0208; Phone: 530-759-8116; http://www.avar.org/.

Atlantic Salmon Federation, International Headquarters, P.O. Box 5200, St. Andrews, New Brunswick E5B 3S8, Canada; Phone: 506-529-1033.

Audubon Naturalist Society, 8940 Jones Mill Rd., Chevy Chase, MD 20815; Phone: 301-652-9188.

Australian Rainforest Conservation Society, 19 Colorado Ave., Bardon Queensland 4065, Australia; Phone: 61-7-3368-1318; http://www.rainforest.org.au/.

Australasian Bat Society: batcall.csu.edu.au/batcall/abs.

Organizations: B
Bat Conservation International, P.O. Box 162603, Austin, TX 78716; Phone: 512-327-9721; http://www.batcon.org/.

Bat Conservation Trust, The, 15 Cloisters House, 8 Battersea Park Rd., London SW8 4BG, England; Phone: 020-7627-2629; http://www.bats.org.uk/.

Beyond Pesticides, 701 E St., SE, #200, Washington, DC 20003; Phone: 202-543-5450; http://www.beyondpesticides.org/.

Biodiversity Resource Center. See California Academy of Sciences. *Pesticides and You* newsletter.

Biogems, project of the Natural Resources Defense Council, 40 West 20th St., New York, NY 10011; Phone: 212-727-2700; http://www.savebiogems.org/.

BirdLife International (formerly the International Council for Bird Preservation),Wellbrook Court, Girton Rd., Cambridge CB3 ONA, United Kingdom; Phone: +44-1-223-277-318. *World Birdwatch*, quarterly newsletter; http://www.birdlife.net/.

Bluewater Network (a project of Earth Island Institute re: ocean conservation and water pollution), 311 California, Suite 510, San Francisco, CA 94104; bluewaternetwork.org.

Bushmeat Crisis Task Force: http://www.bushmeat.org/. Coalition of organizations working to control slaughter of wildlife, especially endangered species such as Chimpanzees, for sale in markets.

Organizations: C
California Academy of Sciences, 55 Concourse Dr., Golden Gate Park, San Francisco, CA 94118-4599; www.calacademy.org/research/library/biodiv/ lists extensive bibliography of regions and species. *California Wild* (formerly *Pacific Discovery*), quarterly magazine published by the Academy by subscription or on newsstands.

Canadian Nature Federation, 1 Nicholas St., Ottawa, Ontario K1N 7B7, Canada; Phone: 1-800-267-4088; http://www.cnf.ca/.

Center for Biological Diversity, P.O. Box 710, Tucson, AZ 85702-0710; Phone: 520-623-5252; http://www.biologicaldiversity.org/.

Center for Captive Chimpanzee Care, P.O. Box 12220, Fort Pierce, FL 34979; Phone: 561-429-0403; http://www.savethechimps.org/.

Center for Coastal Studies, P.O. Box 1036, Provincetown, MA 02657; Phone: 508-487-6115; http://www.coastalstudies.org/. Conducts whale and other marine mammal rescues and research.

Center for Marine Conservation: See The Ocean Conservancy.

Conservation, P.O. Box 299, St. Louis, MO 63166-0299; Phone: 314-577-9450; http://www.mobot.org/cpc.

Center for Safe Energy, Earth Island Institute, 2828 Cherry St., Berkeley, CA 94705; Phone: 510-883-1177; http://www.earthisland.org/cse.

Center for Science in the Public Interest, 1875 Connecticut Ave., NW, Suite 300, Washington, DC 20009; Phone: 202-332-9110; http://www.cspinet.org/.

Center for the Study of Tropical Birds, 218 Conway Dr., San Antonio, TX 78209-1716; Phone: 1-800-858-CSTB; http://www.cstbinc.org/.

Center for Whale Research, 1359 Smugglers Cove, P.O. Box 1577, Friday Harbor, WA 98250-0157; Phone: 360-378-5835; http://www.whaleresearch.com/.

Cetacean Society International, P.O. Box 953, Georgetown, CT 06829; Phone: 203-431-1606; http://www.csiwhalesalive.org/.

Chesapeake Bay Foundation, The, Philip Merrill Environmental Center, 6 Herndon Ave., Annapolis, MD 21403; Phone: 1-888-SAVE-BAY; http://www.savethebay.cbf.org/.

Chihuahuan Desert Research Institute, P.O. Box 905, Ft. Davis, TX 79734; Phone: 915-364-2499; http://www.cdri.org/.

Chimp Haven, Inc., 710 Spring St., Shreveport, LA 71101; Phone: 1-888-98CHIMP; http://www.chimphaven.org/.

Clean Water Action, 4455 Connecticut Ave., NW, Suite A-300, Washington, DC 20003-2328; Phone: 202-895-0420; http://www.cleanwateraction.org/.

Clean Water Network, 1200 New York Ave., NW, Washington, DC 20003; Phone: 202-289-2395; http://www.cwn.org/.

College and University home pages: http://www.utexas.edu/world/univ.

Conservation Foundation (part of World Wildlife Fund), 1250 - 24th St., NW, P.O. Box 97180, Washington, DC 20090-7180; Phone: 202-293-4800; http://www.worldwildlife.org/. United Kingdom: Panda House, Weyside Park, Godalming, Surrey GU7 1XR, United Kingdom; Phone: 01483 426444; http://www.wwf-uk.org/.

Conservation International, 1919 M St., Suite 600, Washington, DC 20036; Phone: 1-800-406-2306; http://www.conservation.org/.

Cornell Lab of Ornithology, 159 Sapsucker Woods Rd., Ithaca, NY 14850-1998; Phone: 1-800-843-BIRD; http://www.birds.cornell.edu/. *Living Bird* journal.

Cousteau Society, The, 870 Greenbrier Cir., Suite 402, Chesapeake, VA 23320-2641; http://www.cousteausociety.org/; Phone: 1-800-441-4395.

Cultural Survival, 215 Prospect St., E., Cambridge, MA 02138; Phone: 617-441-5417; http://www.culturalsurvival.org/.

Organizations: D
Defenders of Wildlife, 1101 - 14th St., NW, Suite 1400, Washington, DC 20005; Phone: 202-682-9400; http://www.defenders.org/. *Defenders*, bimonthly-monthly magazine.

Defensores de la Naturaleza, 19 Avenida fiBfl 0-83, Zona 15, Vista Hermosa II, Guatemala 01015; Phone: 502-369-5167; eco-web.com/register/02222.html.

Desert Tortoise Preservation Committee, 4067 Mission Inn Ave., Riverside CA 92501; Phone: 909-683-3872; http://www.tortoise-tracks.org/.

Dian Fossey Gorilla Fund International, The, 800 Cherokee Ave., SE, Atlanta, GA 30315-1440; Phone: 1-800-851-0203; http://www.gorillafund.org/.

Dolphin Project, The, P.O. Box 224, Coconut Grove, FL 33233; Phone: 305-668-1619. Founder, Richard O™Barry, works to stop capture of wild dolphins and to rehabilitate and release captive dolphins.

Durrell Wildlife Conservation Trust (formerly the Jersey Wildlife Preservation Trust), Les Augres Manor, Trinity, Jersey, Channel Islands JE3 5BP, British Isles; Phone: +44(0)1534 860000; http://www.durrellwildlife.org/. *The Dodo*, annual journal; *The Dodo Dispatch* for young people.

Organizations: E
E. The Environmental Magazine, P.O. Box 2047, Marion, OH 43305-2047; Phone: 815-734-1242; http://www.emagazine.com/. Bimonthly magazine published by Earth Action Network, Inc., Norwalk, CT 06851.

Eagle Nature Foundation, The, 300 E. Hickory St., Apple River, IL 61001; Phone: 815-594-2305; http://www.eaglenature.net/.

Earth First!, P.O. Box 3023, Tucson, AZ 85702; Phone: 520-620-6900; http://www.earthfirstjournal.org/. *Earth First!* newsletter.

Earth Island Institute, 300 Broadway, Suite 28, San Francisco, CA 94133; Phone: 415-788-3666; http://www.earthisland.org/. *Earth Island Journal*, quarterly magazine.

Earthjustice Legal Defense Fund (formerly Sierra Club Legal Defense Fund), 426 - 17th St., 6th Fl., Oakland, CA 94612-2820; Phone: 510-550-6700; http://www.earthjustice.org/. *In Brief*, newsletter

Earthwatch Australia, 126 Bank St., South Melbourne, Victoria 3305, Australia; Phone: 61-3-9682-6828; earthwatch.org/australia/au.html.

Earthwatch Institute, 3 Clock Tower Pl., Suite 100, P.O. Box 75, Maynard, MA 01754-9928; Phone: 1-800-776-0188; http://www.earthwatch.org/.

Eco Travel Center: www.ecotour.org.

Ecological Society of America, 1707 H St., NW, Suite 400, Washington, DC 20006; Phone: 202-833-8773; http://www.esa.org/.

Ecology Fund, 216 E. Huron, Ann Arbor, MI 48104; Phone: 734-213-7777; http://www.ecologyfund.com/. Save open space by clicking on to your choice of threatened animals; e.g., parrot habitat in Mexico, bear habitat in Canada, or around the world.

Ecotourism Society, The, P.O. Box 668, Burlington, VT 05402; Phone: 802-651-9818; http://www.ecotourism.org/.

Elm Research Institute, Elm St., P.O. Box 150, Westmoreland, NH 03467; Phone: 1-800-FOR-ELMS; http://www.forelms.org/. Members receive press releases and can apply for free elm trees; information on projects and saving diseased elms.

Endangered Species Project, 1836 - 14th St., NW, Washington, DC 20009; Fort Mason Center, E-205, San Francisco, CA 94123; Phone: 415-921-3140.

Environmental Action, 6930 Carroll Ave., Suite 600, Takoma Park, MD 20912; Phone: 301-891-1100.

Environmental Defense (formerly Environmental Defense Fund), 257 Park Ave., S., New York, NY 10010; Phone: 212-505-2100; http://www.environmentaldefense.org/.

Environmental Education Associates, P.O. Box 1802, San Anselmo, CA 94979; Phone: 415-281-3388. Integrates environmental material into regular curriculum at school.

Environmental Law Institute, 1616 P St., NW, Suite 200, Washington, DC 20036; Phone: 202-939-3800; http://www.eli.org/.

Environmental Media Services, 1320 - 18th St., NW, 2nd Fl., Washington, DC 20036; Phone: 202-463-6670; http://www.ems.org/.

Environmental News Network, 2020 Milvia, Suite 411, Berkeley, CA 94704; http://www.enn.com/index.asp. Lists sites offering free donations to environmental organizations.

Environmental Resource Center, P.O. Box 819, Ketchum, ID 83340; Phone: 208-726-4337.

Environmental Working Group, 1718 Connecticut Ave., NW, Suite 600, Washington, DC 20009; Phone: 202-667-6982; http://www.ewg.org/.

Organizations: F

Fauna and Flora International, Great Eastern House, Tenison Rd., Cambridge CB1 2TT, United Kingdom; Phone: 44 1223 57 1000; http://www.fauna-flora.org/. *Oryx, The International Journal of Conservation*.

Forests Forever, 973 Market St., Suite 450, San Francisco, CA 94103; Phone: 415-974-3636; http://www.forestsforever.org/.

Forest Service Employees for Environmental Ethics (FSEEE), P.O. Box 11615, Eugene, OR 97440; Phone:

541-484-2692; http://www.fseee.org/.

Forest Stewardship Council, 1155 - 30th St., NW, Suite 300, Washington, DC 20007; Phone: 202-342-6589; http://www.fscus.org/.

Fossil Rim Wildlife Center, P.O. Box 2189, Glen Rose, TX 76043; Phone: 254-897-2960; http://www.fossilrim.org/. Breeds endangered wildlife.

Friends of Animals, 777 Post Rd., Suite 205, Darien, CT 06820; Phone: 203-656-1522; http://www.friendsofanimals.org/. *Action Line*, quarterly magazine.

Friends of the Earth, 1021 Vermont Ave., NW, Washington, DC 20005; Phone: 202-783-7400; http://www.foe.org/.

Friends of the Everglades, 7800 Red Rd., Suite 215-K, Miami, FL 33143; Phone: 305-669-0858; http://www.everglades.org/.

Friends of the Sea Otter, 125 Ocean View Blvd., #204, Pacific Grove, CA 93950; Phone: 831-373-2747; http://www.seaotters.org/. *Sea Otter Raft*, newsletter.

Fund for Animals, 200 West 57th St., New York, NY 10019; Phone: 212-246-2096; http://www.fund.org/.

Fundacao Botanica Margaret Mee, Av. General Justo 171/8e Andar, CEP 2222-1-090, Centro, Rio de Janeiro, RJ Brazil; Phone: 55-21-533-1486.

Fundacao Vitoria Amazonica, Rua R/S Quadra Q, Casa 7, Conjunto Morado do Sol, Manaus, Amazonas 69060-080, Brazil; Phone: 55-92-642-1336.

Organizations: G

Gaia Foundation, C/O Redbridge Community Development Agency, South Ilford Community Centre, Eton Rd., Ilford, Essex 1G1 2UE, United Kingdom; Phone: 44-20-8554-9389; http://www.foundation-gaia.org/.

Global Rivers Environmental Education Network, C/O Earth Force, 1908 Mount Vernon, 2nd Fl., Alexandria, VA 22301; Phone: 703-299-9400; http://www.earthforce.org/green/

Gopher Tortoise Council, C/O Florida Museum of Natural History, University of Florida, P.O. Box 17800, Gainesville, FL 32611; http://www.gophertortoisecouncil.org/. *Tortoise Burrow* and *The Bulletin*, newsletters.

Gorilla Foundation, The, P.O. Box 620530, Woodside, CA 94062; Phone: 1-800-634-6273; http://www.koko.org/. *Gorilla*, quarterly journal.

Great Ape Project International, The, P.O. Box 19492, Portland, OR 97280-0492; http://www.greatapeproject.org/.

Great Bear Foundation, P.O. Box 9383, Missoula, MT 59807; Phone: 406-829-9378; http://www.greatbear.org/. *Bear News*, quarterly newsletter.

Greater Yellowstone Coalition, P.O. Box 1874, 13 S. Wilson, Suite 2, Bozeman, MT 59771; Phone: 406-586-1593; http://www.greateryellowstone.org/.

Greenpeace International, Keizersgracht 176, 1016 DW Amsterdam, The Netherlands; Phone: 31 20 523 6222; http://www.greenpeace.org/.

Greenpeace USA, 702 H St., NW, Suite 300, Washington, DC 20001; Phone: 1-800-326-0959; http://www.greenpeaceusa.org/.

The Greens. Green Party USA, P.O. Box 30208, Kansas City, MO 64112; Phone: 816-931-9366; http://www.greenparty.org/. Grassroots political party committed to ecological values and respect for nature and wildlife.

Organizations: H - I

Humane Society of the United States, 2100 L St., NW, Washington, DC 20037; Phone: 202-452-1100; http://www.hsus.org/. *Humane Society News*, quarterly magazine; *Allanimals*, quarterly magazine.

International Bee Research Association, 18 North Rd., Cardiff, CF10 3DT, United Kingdom; Phone: +44 (0) 2920 372409; http://www.cfac.uk/ibra.

International Bird Rescue Research Center, 4369 Cordelia Rd., Suisun, CA 94585; http://www.ibrrc.org/; Phone: 707-207-0380.

International Crane Foundation, P.O. Box 447, Baraboo, WI 53911; Phone: 608-356-9462; http://www.savingcranes.org/. *ICF Bugle*, newsletter.

International Fund for Animal Welfare, P.O. Box 193, Yarmouth Port, MA 02675; Phone: 508-744-2000 or 1-800-932-IFAW; http://www.ifaw.org/.

International Rivers Network, 1847 Berkeley Way, Berkeley, CA 94703; Phone: 510-848-1155; http://www.irn.org/.

International Snow Leopard Trust, 4649 Sunnyside Ave., N., Suite 325, Seattle, WA 98103; Phone 206-632-2421; http://www.snowleopard.org/.

IUCN (International Union for the Conservation of Nature and Natural Resources), Rue Mauverney 28, CH-1196 Gland, Switzerland; www.iucn.org. Publications Unit: 219c Huntingdon Rd., Cambridge CB4 5PP, United Kingdom; Phone: 44-1223-277894. *Red Lists of Threatened Animals*: http://www.redlist.org/. IUCN publications catalog available at Publications Unit address. Some publications available in the United States from Island Press (1-800-828-1302).

International Wildlife Coalition, 70 E. Falmouth Hwy., East Falmouth, MA 02536; Phone: 508-548-8328; http://www.iwc.org/.

International Wolf Center, 1396 Hwy. 169, Ely, MN 55731-8129; Phone: 218-365-4695; http://www.wolf.org/.

Organizations: J - K - L

Jane Goodall Institute, The, P.O. Box 14890, Silver Spring, MD 20910-4890; Phone: 301-565-0086;

http://www.janegoodall.org/. Primate protection and environmental education, with emphasis on chimpanzees.

Jersey Wildlife Preservation Trust: See Durrell Conservation Trust (United Kingdom) and Wildlife Trust (US).

League of Conservation Voters, 1920 L St., NW, Suite 800, Washington, DC 20016; Phone: 202-785-8683; http://www.lcv.org/.

Loon Preservation Committee, P.O. Box 604, Moultonborough, NH 03254; Phone: 603-476-5666; http://www.loon.org/.

Organizations: M

Marine Education Center of Cape Ann, P.O. Box 3015, Gloucester, MA 01930; Phone: 415-289-7325; http://www.cape-ann.com/. Rescues and rehabilitates injured and stranded marine mammals.

Marine Mammal Center, The, Marin Headlands, 1065 Fort Cronkhite, Sausalito, CA 94965; Phone: 415-289-7325; http://www.tmmc.org/. Rescues and rehabilitates injured and stranded marine mammals.

Massachusetts Audubon Society, 208 South Great Rd., Lincoln, MA 01773; Phone: 781-259-9661; http://www.massaudubon.org/. *Sanctuary*, bimonthly magazine.

Missouri Botanical Garden, St. Louis, MO 63101; Phone: 314-577-5100; http://www.mobot.org/. Information on endangered plants, including tropical forest species.

Mountain Gorilla Conservation Fund, P.O. Box 2211, Englewood, CO 80150-2211; Phone: 303-781-3484; http://www.mountaingorillaconservationfund.org/ and http://www.gorilla100.com/.

Museums in the United States: http://www.museumca.org/usa.

Organizations: N

National Audubon Society, 700 Broadway, New York, NY 10003; Phone: 212-979-3000; http://www.audubon.org/. *Audubon*, bimonthly magazine available by subscription and on newsstands.

National Coalition for Marine Conservation, 3 N. King St., Leesburg, VA 20176; Phone: 703-777-0037; http://www.savethefish.org/.

National Foundation to Protect America™s Eagles, Save the Eagle Project, P.O. Box 120206, Nashville, TN 37212; Phone: 615-847-4171.

National Geographic Society, 1145 - 17th St., NW, Washington, DC 20036; Phone: 202-857-7000; http://www.nationalgeographic.com/. *National Geographic*, monthly publication available by subscription and on newsstands. *World Magazine*, publication for young people, includes articles on endangered species and habitat.

National Parks and Conservation Association, 1300 - 19th St., NW, Suite 300, Washington, DC 20036; Phone: 1-800-628-7275; http://www.npca.org/. *National Parks* magazine for members.

National Wildflower Research Center, Lady Bird Johnson Wildflower Center, 4801 LaCrosse Ave., P.O. Box 149187, Austin, TX 78739; Phone: 512-292-4200; http://www.wildflower.org/. *Wildflower*, bimonthly newsletter for members.

National Wildlife Rehabilitators Association, 14 N. Seventh Ave., St. Cloud, MN 56303-4766; Phone: 320-259-4-86; http://www.nwrawildlife.org/.

Native Forest Council, P.O. Box 2190, Eugene, OR 97402; Phone: 541-688-2600; http://www.forestcouncil.org/.

Native Seeds/SEARCH, 526 N. Fourth Ave., Tucson, AZ 85706; Phone: 520-622-5561; http://www.nativeseeds.org/. Distributes seeds of indigenous North American plants. *The Seedhead News*.

Natural Resources Defense Council, 40 West 20th St., New York, NY 10011; Phone: 212-727-2700; http://www.nrdc.org/.

Nature Conservancy, The, 4245 N. Fairfax Dr., Suite 100, Arlington, VA 22203-1606; Phone: 1-800-628-6860; nature.org. *Nature Conservancy*.

Negative Population Growth, 1717 Massachusetts Ave., NW, Suite 101, Washington, DC 20036; Phone: 202-667-8950; http://www.npg.org/.

New England Aquarium, Central Wharf, Boston, MA 02110; Phone: 617-973-5200; http://www.neaq.org/. Programs include rescue of marine mammals and sea turtles and rehabilitation for release.

New England Wild Flower Society, 180 Hemenway Rd., Framingham, MA 01701-2699; http://www.newfs.org/; Phone: 508-877-7630. *New England Wild Flowers*, magazine published three times a year. Web site includes *Directory of Native Plant Societies*.

New York Times Science Times: http://www.nytimes.com/.

North American Bluebird Society, The Wilderness Center, P.O. Box 244, Wilmot, OH 44689-5511; http://www.nabluebirdsociety.org/; Phone: 330-359-5511. *Bluebird*, newsletter.

North American Butterfly Association, 4 Delaware Rd., Morristown, NJ 07960; www.naba.org. *American Butterflies* and *Butterfly Gardener*.

North American Loon Fund, P.O. Box 68, Mt. Pleasant, MI 44804; facstaff.uww.edu/wentzl/nalf/analfhomepage.html; Phone: 989-772-9611.

North American Native Fishes Association, 1107 Argonne Dr., Baltimore, MD 21218; http://www.nanfa.org/.

Organizations: O

Ocean Conservancy, The (formerly Center for Marine Conservation), 1725 DeSales St., NW, Suite 500, Washington, DC 20036; http://www.oceanconservancy.org/; Phone: 202-429-5609. *The Blue Planet*, quarterly magazine.

Ocean Realm (quarterly magazine), 4067 Broadway, San Antonio, TX 78209; http://www.oceanrealm.net/; Phone:

210-824-8099.

Oil Spill Intelligence Report: http://www.cutter.com/.

Orangutan Foundation International, 822 S. Wellesley Ave., Los Angeles, CA 90049; http://www.orangutan.org/; Phone: 1-800-ORANGUTAN. Founder, Birute Galdikas, directs rescue and rehabilitation of orphaned and confiscated orangutans on Borneo and conducts scientific research on the species™ ecology and conservation.

Orion Society, 187 Main St., Great Barrington, MA 01230; orionline.org; Phone: 1-800-909-6568 or 413-528-4422. *Orion. People and Nature* quarterly magazine.

Organizations: P

People for the Ethical Treatment of Animals (PETA), 501 Front St., Norfolk, VA 23510; http://www.peta.org/; Phone: 757-622-7382. *PETA™s Animal Times*, quarterly magazine.

Peregrine Fund, The, 5666 W. Flying Hawk Ln., Boise, ID 83709; http://www.peregrinefund.org/; Phone: 208-362-3716.

Performing Animal Welfare Society (PAWS), P.O. Box 849, Galt, CA 95632; http://www.pawsweb.org/; Phone: 866-FOUR-PAWS; 209-745-2606. Fights cruelty against elephants and big cats in zoos and circuses and runs an animal sanctuary.

Pesticide Action Network, 49 Powell St., Suite 500, San Francisco, CA 94102; http://www.panna.org/; Phone: 415-981-1771.

Pew Wilderness Center, Protecting America™s Wilderness and Natural Heritage, 122 C St., NW, Suite 240, Washington, DC 20001; http://www.pewwildernesscenter.org/; Phone: 202-544-3691.

Planned Parenthood Federation of America: http://www.plannedparenthood.org/. State and regional offices are listed along with publications and member services.

Population Action International, 1300 - 19th St., NW, 2nd Fl., Washington, DC 20036; http://www.populationaction.org/; Phone: 202-557-3400. Web site lists many publications.

Population Communications international, 777 United Nations Plaza, New York, NY 10017-3521; http://www.population.org/; Phone: 212-687-3366.

Population Connection (formerly Zero Population Growth), 1400 - 16th St., NW, Suite 320, Washington, DC 20036; http://www.populationconnection.org/; Phone: 202-332-2200.

Population Institute, The, 107 Second Ave., NE, Washington, DC 20002; http://www.populationinstitute.org/; Phone: 202-544-3300.

Predator Conservation Alliance, P.O. Box 6733, Bozeman MT 59771; http://www.predatorconservation.org/; Phone: 406-587-3389. *The Home Range*, quarterly newsletter.

Primarily Primates, P.O. Box 207, San Antonio, TX 78291-0207; http://www.primarilyprimates.org/; Phone:

830-755-4616.

Pro Natura USA, 8123 Heatherton Ln., #104, Vienna, VA 22180; Phone: 703-641-5900.

Pro Natura International, 61, Green Ridges, Headington, Oxford OX3 8PL, United Kingdom.

Pro Natura Brazil, Ave., Beira Mar 406, Sala 708/709, Castelo, Rio de Janeiro 22021.060, Brazil.

Public Citizen and Public Citizen Health Group, 1600 - 20th St., NW, Washington, DC 20009; http://www.citizen.org/; Phone: 202-588-1000.

Public Interest Research Group (PIRG), 218 D St., SE, Washington, DC 20003; http://www.pirg.org/; Phone: 202-546-9707.

Organizations: Q Œ R

Rainforest Action Network, 221 Pine St., Suite 500, San Francisco, CA 94104; http://www.ran.org/; Phone: 415-398-4404. *World Rainforest Report*, newsletter for members. Rainforest teacher™s packet available.

Rainforest Alliance, 65 Bleecker St., New York, NY 10012; http://www.rainforestalliance.org/; Phone: 212-677-1900.

Rainforest Foundation US, The, 270 Lafayette St., Suite 1107, New York, NY 10012; Phone: 212-431-9098. Headquarters: Suite A5, City Cloisters, 196 Old St., London EC1V 9FR, United Kingdom; Phone: +44 (0) 20-7251-6345. Organization founded by rock artist Sting to promote conservation of rainforests and their native peoples.

Rainforest Relief, P.O. Box 150566, Brooklyn, NY 11215; http://www.rainforestrelief.org/; Phone: 718-398-3760. *Raindrops, Rainforest Relief Reports*, newsletter.

Raptor Center, The, Gabbert Raptor Building, 1920 Fitch Ave., St. Paul, MN 55108; http://www.raptor.cvm.umn.edu/; Phone: 612-624-4745. *Raptor Release*, newsletter.

RARE Center for Tropical Conservation, 1840 Wilson Blvd., Suite 402, Arlington, VA 22201-3000; http://www.rarecenter.org/; Phone: 703-522-5070. *RARE Center News*, newsletter.

Riverkeeper, P.O. Box 130, Garrison, NY 10524; http://www.riverkeeper.org/; Phone: 845-424-4149. Lists regional organizations specializing in particular rivers.

Rocky Mountain Institute, 1739 Snowmass Creek Rd., Snowmass, CO 81654-9199; Phone: 970-927-2851. Environmentally friendly sources of energy, architecture, transportation, energy efficiency.

Organizations: S

Save America™s Forests, 4 Library Ct., SE, Washington, DC 20003; http://www.saveamericasforests.org/; Phone: 202-544-9219. *Save America™s Forests Magazine*

Save the Manatee Club, 500 N. Maitland Ave., Maitland, FL 32751; http://www.savethemanatee.org/; Phone: 407-539-0990.

Save the Redwoods League, 114 Sansome St., Room 1200, San Francisco, CA 94104-3823; http://www.savetheredwoods.org/; Phone: 415-362-2352.

Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Dr., La Jolla, CA 92093; www.sio.ucsd.edu/ ; Phone: 858-534-3624.

Sea Shepherd Conservation Society, 22774 Pacific Coast Hwy., Malibu, CA 90265; www.seashepherd.org; Phone: 310-456-1141.
Sea Turtle Restoration Project, P.O. Box 400, Forest Knolls, CA 94931; http://www.seaturtles.org/ ; Phone: 415-488-0370. Free catalog.

SeaWeb, 1731 Connecticut Ave., NW, 4th Fl., Washington, DC 20009; http://www.seaweb.org/ ; Phone: 202-483-9570.

Sierra Club, 85 Second St., 2nd Fl., San Francisco, CA 94105-3441; http://www.sierraclub.org/ ; Phone: 415-977-5500. *Sierra* magazine by subscription and on newsstands.

Sierra Club Legal Defense Fund: See Earthjustice Legal Defense Fund.

Sierra Club Student Coalition, P.O. Box 2402, Providence, RI 02906; http://www.ssc.org/ ; Phone: 1-888-JOIN-SSC.

Society for Animal Protective Legislation, P.O. Box 3719, Georgetown Station, Washington, DC 20007; http://www.saplonline.org/ ; Phone: 202-337-2334. This is the Animal Welfare Institute™s companion organization for legislative issues.

Society for Conservation Biology, 4245 N. Fairfax Dr., Arlington, VA 22203; http://www.conbio.org/ ; Phone: 703-276-2384. *Conservation Biology*, quarterly journal with articles by scientists on conservation, endangered species and related topics; and *Conservation Biology in Practice*.

Society for the Preservation of Birds of Prey, P.O. Box 66070, Los Angeles, CA 90066; Phone: 310-840-2322. *The Raptor Report*, newsletter.

Society of Tympanuchus Cupido Pinnatus, Ltd. (Society of the Greater Prairie Chicken), Stone Ridge II, Suite 280, Stone Ridge Dr., Waukeha, WI 53188; Phone: 414-523-3600. *Boom*, newsletter.

Solar Energy International, P.O. Box 715, Carbondale, CO 81623-0715; http://www.solarenergy.org/ ; Phone: 970-963-8855. *Home Power*, magazine.

Southern Environmental Law Center, 201 W. Main St., Suite 14, Charlottesville, VA 22902-5065; http://www.selcga.org/ ; Phone: 434-977-4090.

Stanford University Center for Conservation Biology: www.stanford.edu/group/CCB .

Student Environmental Action Coalition, National Office, P.O. Box 31909, Philadelphia, PA 19104-0609; http://www.seac.org/ ; Phone: 215-222-4711.

Suncoast Seabird Sanctuary, Inc., 18328 Gulf Blvd., Indian Shores, FL 33785; http://www.seabirdsanctuary.org/ ; Phone: 727-391-6211. Treats and rehabilitates injured seabirds, especially those who have swallowed fish hooks or

have become entangled in fishing lines.

Survival International, 6 Charterhouse Bldg., London EC1M 7ET, United Kingdom; http://www.survival-international.org/ ; Phone: 00-44-20-7687-8700.

Organizations: T

Tiger Trust, The: www.fontayne.com/tigertrust/ . *Tiger News*, biannual journal.

TRAFFIC International, 219c Huntingdon Rd., Cambridge CB3 ODL, United Kingdom; http://www.traffic.org/ ; Phone: (44) 1-223-27723. *TRAFFIC Bulletin*, quarterly publication on wildlife trade.

TRAFFIC USA, 1250 - 24th St, NW, Washington, DC 20037; www.traffic.org/25/network6.htm ; Phone: 202-293-4800. Newsletter on wildlife trade; affiliated with World Wildlife Fund.

Trumpeter Swan Society, The, 3800 County Road 24, Maple Plain, MN 55359; www.taiga.net/swans/ ; Phone: 763-476-4663. *Bulletin of the Trumpeter Swan Society*.

Trust for Public Lane, 116 New Montgomery St., 4th Fl., San Francisco, CA 94105; http://www.tpl.org/ ; Phone: 415-495-4014.

Organizations: U Œ V Œ W

Union of Concerned Scientists, 2 Brattle Square, Cambridge, MA 02238; http://www.ucsusa.org/ ; Phone: 617-547-5552.

WhaleNet, 200 The Riverway, Boston, MA 02215; www.whalenet.org or http://www.wheelock.edu/ .

Whooping Crane Conservation Association, 1393 Henderson Hwy., Breaux Bridge, LA 70517; http://www.whoopingcrane.com/ .

Wild Canid Survival and Research Center, Washington University™s Tyson Research Center, P.O. Box 760, Eureka, MO 63025; http://www.wolfsanctuary.org/ ; Phone: 636-938-5900. *Wild Canid Center Review*.

Wild Sentry, The Northern Rockies Ambassador Wolf Program, Inc., P.O. Box 172, Hamilton, MT 59840; www.bitterroot.net/wild ; Phone: 406-363-7291.

Wilderness Society, The, 1615 M St., NW, Washington, DC 20016; http://www.wilderness.org/ ; Phone: 1-800-THE-WILD. *Wilderness*, magazine.

Wildlife Connection, The, P.O. Box 719, Jasper, AR 72641; Phone: 502-524-2396. Education and rehabilitation.

Wildlife Conservation Society, Bronx Zoo/Wildlife Conservation Park, 2300 Southern Blvd., Bronx, NY 10460; http://www.bronxzoo.com/ ; Phone: 718-220-5100. Virtual tour and information on the programs of the Wildlife Conservation Society to preserve rainforests in the Congo; saving endangered species. *Wildlife Conservation*, bimonthly magazine by subscription and on newsstands; http://www.wildlifeconservation.org/ .

Wildlife Society, The, 5410 Grosvenor Ln., Bethesda, MD 20814; www.wildlife.org; Phone: 301-897-9770.

Wildlife Trust (formerly US partner of the Jersey Wildlife Preservation Trust), 61 Route 9W, Palisades, NY 10964-8000; http://www.wildlifetrust.org/ ; Phone: 845-365-8337. *On the Edge*, a quarterly magazine for members.

Wolf Education and Research Center, The, P.O. Box 217, Winchester, ID 83555; http://www.wolfcenter.org/ ; Phone: 208-924-6960.

Woods Hole Oceanographic Institution, 360 Woods Hole Rd., Woods Hole, MA 02543-1541; http://www.whoi.edu/ ; Phone: 508-548-2219.

World Bird Sanctuary, P.O. Box 270270, St. Louis, MO 63127; http://www.worldbirdsanctuary.org/ ; Phone: 636-861-3225. Propagation and rehabilitation of exotic parrots and other birds.

World Conservation Monitoring Centre, 219c Huntingdon Rd., Cambridge CB3 0DL, United Kingdom; http://www.unep-wcmc.org/ ; Phone: 44 (0) 1223-277314. Affiliated with the International Union for the Conservation of Nature (IUCN) and World Wildlife Fund, it compiles information on endangered species and wildlife trade.

World Conservation Union: See International Union for the Conservation of Nature and Natural Resources (IUCN).

World Rainforest Movement, P.O. Box 1539, Montevideo 11000, Uruguay; www.chasque.apc.org/item ; Phone: +598-2-419-6292.
World Resources Institute, 10 G St., NE, Washington, DC 20002; www.wri.org; Phone: 202-729-7600.

World Society for the Protection of Animals (WSPA) Headquarters: 89 Albert Embankment, London SE1 7TP, United Kingdom; Phone: 44 (0) 20-7587-5000.
US: 34 Deloss St., Framingham, MA 01702; http://www.wspa-americas.org/ ; Phone: 508-879-8350. *Animals International* and *The Protector*, newsletters.

World Species List (many endangered species lists): www.envirolink.org/species .

World Wildlife Fund US, 1250 - 24th St., NW, P.O. Box 97180, Washington, DC 20090-7180; http://www.wwf.org/ ; Phone: 202-293-4800. *Focus*, newsletter; *Living Planet*, quarterly magazine.

Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC 20036-1904; http://www.worldwatch.org/ ; Phone: 202-452-1999. *State of the World* and *Worldwatch*.

Worldwide Fund for Nature, Avenue du Mont-Blanc, 1196 Gland, Switzerland; http://www.panda.org/ ; Phone: +41-22-364-91-11.

Organizations: X Œ Y - Z
Yellowstone Ecosystem Studies, P.O. Box 6640, Bozeman, MT 59771; www.c-t-g.com/yellowstone ; Phone: 406-587-7558.

Xerces Society, 4828 SE Hawthorne Blvd., Portland, OR 97215-3252; http://www.xerces.org/ ; Phone: 503-232-6639. Newsletter concerning the preservation of butterflies and other invertebrates.

Zero Population Growth: See Population Connection.

Teachers' Aids and Educational Materials

Teachers' Aids
The American Biology Teacher. Published by the National Association of Biology Teachers, 12030 Sunrise Valley Dr., Reston, VA 20191; www.nabt.org; Phone: 1-800-406-0775. Although not primarily concerned with endangered species, this magazine occasionally has information on this subject.

Bullfrog Films™ catalog includes an extensive collection of educational films on the environment and wildlife, many of which are thought provoking and could serve as the basis for discussion. The catalog lists recommended grade levels and awards, accreditation and other background information on each film along with descriptions of the content. Some of the films are reviewed in the video section. www.bullfrogfilms.com; Phone: 1-800-543-3764.

Discovery Channel School. fiDiscovery Channel School K-12 Catalogfl lists materials, such as CD-ROMs and videos, which are packaged together. For example, the Insects packet includes a CD-ROM, a student resource book, fiInsect Files,fl a Teachers™ A-Z Resource Guide on Insects, and an Internet site featuring electron microscope images of insects and fiB-Eye: The World Through the Eyes of a Beefl to show what a flower looks like to a bee. Other packets with CD-ROMs, teachers™ guides and student resource books include: fiPlants,fl fiReptiles,fl fiFish and Amphibians,fl fiInvertebrates,fl fiProtists and Fungi,fl fi Mammals,fl fiBirds,fl fiEvolutionfl and fiEcology.fl The latter title™s Internet link features suggestions on projects to save beaches, a global warming debate about coral reefs, and fiEarth Today.fl Each CD-ROM contains a long video as well as library searches of references, a digital lab and instructions for presentations of slides, text and sound effects to be created by the students. Among the selections in the fiEarth Sciencefl CD-ROM bundle is fiConservation of Natural Resources.fl The latter CD-ROM is also offered in a bundle along with a student resource book, a teacher™s guide and Internet links. Videos geared toward school classes have themes divided into segments. Titles for grades 6 to 12 include: fiFinite Oceansfl on the limits of oceans to absorb pollutants and provide resources; fiCoral Reefsfl explores the Red Sea, an extremely diverse coral ecosystem; fiUnderstanding Oceansfl explains their movements, tides, endangered creatures and experts; fiWater: To the Last Dropfl investigates the contamination and misuse that threatens the limited supplies of freshwater upon which we depend; www.discoveryschool.com.

Conserving Earth™s Biodiversity by Edward O. Wilson and Dan L. Perlman, 1999. Island Press, Covelo, CA (interactive CD-ROM teaching conservation biology and environmental science). Teachers can register for an examination copy and view a demo at: www.islandpress.org/wilsoncd. Senior author is Harvard University professor, author of *The Diversity of Life* and editor of *Biodiversity*, key books on the subject.

Earthwatch. This bimonthly periodical, published by Earthwatch, is available by subscription and is sold by many

newsstands. Earthwatch sponsors research projects by scientists. Contributors, scholarship and fellowship students may accompany scientists on their expeditions. Projects have included studies of threatened plants and animals and their disappearing habitats in Australia, Brazil and Thailand; endangered sea turtle ecology in Baja California, Mexico; and Florida Manatees. A typical project is carried out by a scientist affiliated with a well-known university or institution. Volunteers pay to assist the scientists by making observations, taking photographs and performing miscellaneous duties for a period of about two weeks. Active participation in the study depends on the health, interests and abilities of the volunteer. Many teachers go on expeditions, taking copious notes and photos, and use the experience as a teaching outline for courses. Students may also be sponsored by their class or family. Volunteers must be 16 years or older. For those unable to participate in research trips, project briefings are available for $15 each, written by the scientists heading each project, with background information and results as available. There are scholarships and fellowships offered to selected applicants. Earthwatch Institute, 3 Clock Tower Place, Suite 100, P.O. Box 75, Maynard, MA 01754-9928; Phone: 1-800-776-0188; www.earthwatch.org has more than 5,000 pages of background information on projects, a global classroom, an education site, and a virtual expedition. The site has won more than 25 awards for excellence.

Endangered Means There™s Still Time This free US Fish and Wildlife Service brochure explains the basic causes endangering species. The brochures, fiPlacing Animals and Plants on the List of Endangered and Threatened Speciesfl and fiESA Basicsfl explain the listing process, critical habitat and other facets of the US Endangered Species Act. fiWhy Save Endangered Species?fl presents strong arguments for the preservation of biodiversity as it benefits human health and agriculture and tells how animals can be barometers of environmental quality, warning us of the dangers of pesticides, for example. Other brochures include profiles of the Mexican Wolf, Red Wolf, Whooping Crane and others. fiConserving Borderline Species, A Partnership between the United States and Canadafl is a report describing the cooperative programs that have helped Whooping Cranes, Swift Foxes, Black-footed Ferrets and other wildlife and plants that inhabit both sides of the Canada/US border region. A poster entitled fiThe Road to Recoveryfl illustrates some of the species that, because of the Endangered Species Act, have increased in numbers from Near-extinction: the Grizzly Bear, Bald Eagle, Lange™s Metalmark Butterfly, Gray Whale and Greenback Cutthroat Trout. By calling the Publications Unit of the US Fish and Wildlife Service (304-876-7203) or the Office of Endangered Species, one can also request fact sheets on a selected number of US endangered species and copies of US Fish and Wildlife Service publications (USFWS, 4401 N. Fairfax Dr., Arlington, VA 22203; www.fws.gov/). Further information on US endangered species is available from www.natureserve.org, a private database providing legal status and general information on all species listed by The Nature Conservancy as Imperiled.

Environmental Vacations: Volunteer Projects to Save the Planet, by Stephanie Ocko, 2nd edition, John Muir Publications, 1992. Distributed by W.W. Norton & Co., 248 pages. This book describes ways in which nonscientists can assist experts in activities (such as monitoring the diversity of rainforests), observing animal behavior or other projects, giving particulars on the projects and how to become involved.

The Globe program for classrooms involves students from around the world who participate in ecology studies by gathering and analyzing data; ncdc.noaa.gov/GLOBE/globe.html. It is affiliated with the National Oceanic and Atmospheric Administration (NOAA).

Green Teacher, P.O. Box 1431, Lewiston, NY 14092; or in Canada, 95 Robert St., Toronto, Ontario M5S 2K5, Canada. Five issues per year, $27.00; sold on newsstands also. This magazine is very well done. It lists environmental projects and activities and has a humane orientation. Some articles are in both French and English.

Knowledge Unlimited, P.O. Box 52, Madison, WI 53701-0052; www.ku.com. This catalog lists videos, filmstrips, resource guides, classroom posters, books and other educational materials under major categories, including Science, which has many listings on endangered species and environmental topics.

National Geographic Society. The Educational Services department of the National Geographic Society provides material, films and filmstrips on general science and biology, including endangered species and habitats. Its free catalog, fiSchool Publishing,fl for Grades K-12 offers a wide variety of environmental books, videos, CD-ROMs and other visual material accompanied by teachers™ guides. An Internet site designed for teachers gives further detail: www.nationalgeographic.com/education. One learning packet centers on the Tiger. The teaching guide includes lessons on habitat, populations, adaptation, predator/prey relationships, conservation and scientific studies, accompanied by two videos the society produced on the species, slides, posters and student handouts. Another teaching unit describes The Jason Project Expeditions, sponsored in part by the National Geographic Society. Each centers on a part of the world. These kits combine studies of a variety of disciplines centered on an area or country: biology, climate study, geology and others.

Students learn how to measure pollutants and study endangered species™ diets. These lessons are also shown on the new National Geographic television channel. An interactive encyclopedia CD-ROM on Mammals, for Grades 2-12, allows students to see and hear more than 200 mammals through photos, range maps, acoustics, facts on endangered species, mystery games that test powers of deduction, and a lesson plan booklet. Videos made for the classroom on many subjects include a series on bioscience, showing life cycles of various insects, a trout river ecosystem, and other themes for various grade levels. Each includes a teacher™s guide and is described in the Teacher Store page or in the Video and Media Catalog. Anatomy of frogs and other animals are included in material that teaches function, taxonomy and structure. For the growing number of teachers and students who would rather find another means of learning about frog or mammal anatomy rather than dissection, especially in view of the declining status of frogs, this material provides a solution. (Also see the Projects Section in this book, fiLearning Animal Anatomy Without Dissection.fl)

Rainforest Teacher™s Packet.Rainforest Action Network, 221 Pine St., Suite 500, San Francisco, CA 94104. Educational materials listed on www.ran.org; Phone: 415-398-4404. Students and others may sign up for fiaction alertsfl on issues affecting the world™s rainforests.

The Rainforest Book. How you can save the world™s rainforests, by Scott Lewis with the Natural Resources Defense Council, Living Planet Press, 1990. Aimed toward students, the text has chapters on the importance of rainforests, both tropical and US temperate rainforests, how they can be saved and how individuals can help with specific examples of aiding organizations, encouraging local businesses not to buy rainforest products, visiting rainforests, adopting an acre of rainforest, and further reading, films and other information sources.

Save America™s Forest. Citizen Action Guide The activist organization, Save America™s Forests, has published a 51-page how-to guide for citizens and/or students to work within communities to educate others on the decline of America™s forests from clearcutting and over-harvesting. It is available online at www.saveamericasforestsfund.org. Also available from this organization, a slide show, fiClearcuts Coast to Coastfl (purchase or rental); an annotated bibliography on forests; and the award-winning video, fiThe Last Ancient Forestsfl (11 minutes, purchase $7). Save America™s Forests, 4 Library Ct., SE, Washington, DC 20003; www.saveamericasforests.org; Phone: 202-544-9219.

Science Teacher. National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201-3000; Phone: 703-243-7100; www.nsta.org. Published nine times a year, this is a valuable periodical, aiding teachers of

environmental subjects.

Teacher™s Guide to World Resources and Biodiversity(ISBN 0-7872-4259-4), 2001. This guide provides economic, ecological, ethical and esthetic reasons why we should care that species are becoming extinct. Students explore the root causes of biodiversity loss and strategies for conservation. Cost is $9.99. Published and distributed by Kendall Hunt, it can be ordered online through their Web site. The site also includes fiEndangered Forestsfl and many other titles on the environment. Discounts are given to teachers who order in bulk. Web site: www.kendallhunt.com; Phone: 1-800-542-6657.

fiUnderstanding Biodiversity.fl Encyclopedia Britannica™s 19-minute video is aimed at high school students. It stresses the need for ecosystems to have diverse life forms and the important roles different types of scientists play in biodiversity preservation. The cloud forests of Venezuela are the background for teaching this subject. A Teacher™s Guide is included, listing objectives and suggestions for classroom discussion topics. Encyclopedia Britannica Educational Corporation (1-800-554-9862).

fiBritannica. Electronic Media Catalogfl descries many videos (without teachers™ guides) on the environment and wildlife. It also offers a fiGuide to Dissection,fl in which a video software package with four parts shows dissections of a rat, frog, pigeon and dogfish. Using software, the student can do a virtual dissection with a computer mouse.

Video Project. Free catalog of educational environmental videos for use in schools and libraries. Video Project, P.O. Box 77188, San Francisco, CA 94107; Phone: 1-800-4-PLANET; www.videoproject.net.

The Wild Ones. The Wildlife Trust (formerly the Wildlife Preservation Trust) is a sister organization to the Durrell Conservation Trust in the United States, founded by Gerald Durrell, noted author and conservationist, which works on environmental and endangered species programs throughout the world. For students, the organization sponsors fiThe Wild Onesfl (www.thewildones.org), which includes a newsletter, *The Wild Ones*, and accompanying fiTeacher Connection,fl both of which can be downloaded from its Web site. The latter enrolls classes and provides suggestions for curriculum activities involving conservation, endangered species, natural history and related topics that complement the newsletter. *The Wild Ones* is also published in other countries, such as Mexico, translated into Spanish, with added topics pertaining to that country™s environment and wildlife.

Letters and artwork from students around the world are published on the site. Through the Web site, students can write the scientists working on various projects for the organization. The newsletter for the general membership, *On the Edge*, often focuses on particular endangered species; recent issues may be accessed through the Web site under fiField Notes,fl with the year of publication. The organization in the United Kingdom, which publishes the newsletter *The Dodo Dispatch* (ages 7-16), and the Canadian sister organization can be reached through the Web site as well. The Wildlife Trust, 61 Route 9W, Palisades, NY 10964-8000; Phone: 845-365-8337; www.wildlifetrust.org.

Wildlife Review Abstracts, National Information Services Corporation, 3100 St. Paul St., Suite 806, Baltimore, MD 21218. Formerly a quarterly report published by the US Fish and Wildlife Service, these annotated bibliographies are now a privately run database system with 514,000 entries of publications on wildlife and the environment, indexed by species, subject and geographical areas. Abstracts from wildlife, fisheries, ornithological, ecological and forestry journals are sold through a yearly subscription for $1,045. The data is available on CD-ROM and is compiled from many sources. The Wildlife Species Information Library at the site includes data on habitats in states from a DOS-based CD-ROM or 45,000 pages of online species™ profiles. Phone: 410-243-0797; www.nisc.com.

Internet
All Endangered Species:
IUCN Red List of Threatened Species: www.redlist.org/
FWS Endangered Species Program: www.fws.gov/endangered/
WWF Wildfinder: www.worldwildlife.org/wildfinder/

Bats:
Bat Conservation International: www.batcon.org
www.bahnhof.se/~pettersson (identifying bats by their sound waves)
Swedish Bat Detector company: www.batsound.com.

Bears:
Nature Net: www.naturenet.com/bears/.
Discovering Lewis & Clark: www.lewis-clark.org.
Yellowstone National Park: www.yellowstone-natl-park.com/bearstor.htm.
Great Bear Foundation: www.greatbear.org.

Birds:
The Peregrine Fund: www.peregrinefund.org
(California Condor and other reintroduced endangered birds of prey).
Warbler Watch of Cornell Laboratory of Ornithology and National Audubon Society: birdsource.cornell.edu.
US Fish and Wildlife Service, endangered species breeding center at Patuxent Wildlife Research Center: mbr-pwrc.usgs.gov/bbs/ident.html.
Peterson Multimedia Guides: (sightings of rare birds): www.petersononline.com.
The Raptor Center, University of Minnesota (tracks Ospreys in their winter migration): www.raptor.cvm.umn.edu.

Butterflies:
Bugbios: insects.org/ced4/symbol_list3.html.
Journey North: learner.org/jnorth/current.html (tracing Monarch Butterfly migrations to Mexico, with classroom participation in the United States and Mexico).
Cornell Center for the Environment: www.cfe.cornell.edu (projects to monitor butterfly populations).
A World for Butterflies: www.aworldforbutterflies.com (Dr. Philip Shappert, editor of *News of the Lepidopterists™ Society* and author of *A World for Butterflies*).

Marine Species:
Sea Turtle Survival League: www.cccturtle.org (sea turtle tracking with satellite transmitters).
The Karen Beasley Sea Turtle Rescue and Rehabilitation Center: www.seaturtlehospital.org (hospital for injured and sick sea turtles, many with shattered shells from boat collisions and infections from pollution during nesting season, volunteers protect 100 nests and hatchlings).
University of Maine™s Lobster Institute: www.lobster.um.maine.edu/lobster
(live video of lobsters in the wild).
SeaWeb: www.seaweb.org (marine education).
Ocean Planet, The Smithsonian Institution: seawifs.gsfc.nasa.gov/oceanplanet.html
(traveling exhibits with links to background material).
Woods Hole Oceanographic Institution: www.whoi.edu

(research projects and access to its library and oceanographic sites).
Mote Marine Laboratory: www.marinelab.sarasota.fl.us
(information about red tides and sea turtle rehabilitation).
SeaWatch: www.seawatch.org or www.seawatchfoundation.org.uk.

Wolves and Wild Dogs:
NOVA/PBS: www.pbs.org/wgbh/nova/wolves.
Penn State College of Earth and Mineral Sciences: www.ems.psu.edu.
Yellowstone Wolf Report: yellowstone-natl-park.com/wolf.html.
Wolf Haven International: www.wolfhaven.org.
Wolf Education and Research Center: www.wolfcenter.org.
Defenders of Wildlife wolf program: www.defenders.org.

Timber Wolf Information Network: www.timberwolfinformation.org.
Wild Canid Survival and Research Center: www.wolfsanctuary.org.
The Association for Nature fiWolffl: www.most.org.pl/wolf
(Godziszka, Poland; wolves in Poland and Europe).
International Wolf Center: www.wolf.org.
Dhole home page: www.cuon.net/dholes (information on the Asiatic wild dog, its biology, research and conservation).

Organizations

A Œ B Œ C Œ D Œ E Œ F Œ G Œ H Œ I Œ J - K - L - M

N Œ O Œ P Œ Q Œ R Œ S Œ T Œ U Œ V Œ W Œ X Œ Y - Z

Organizations: A

African Wildlife Foundation, 1400 - 16th St., NW, Suite 120, Washington, DC 20036; Phone: 202-939-3333; http://www.awf.org/. Quarterly magazine, *African Wildlife News*.

Alaska Wildlife Alliance, P.O. Box 202022, Anchorage, AK 99520-2022; Phone: 907-277-0897; http://www.akwildlife.org/.

Alliance for the Wild Rockies, P.O. Box 8731, Missoula, MT 59807; Phone: 406-721-5420; http://www.wildrockiesalliance.org/.

Amazon Conservation Team, 4211 N. Fairfax Dr., Arlington, VA 22203; Phone: 703-522-4684; http://www.ethnobotany.org/.

American Anti-Vivisection Society, 801 Old York Rd., #204, Jenkintown, PA 19046-1685; Phone: 215-887-0816; http://www.aavs.org/.

American Association of Botanical Gardens and Arboreta, 351 Longwood Road, Kennett Square, PA 19348; Phone: 610-925-2500; http://www.aabga.org/.

American Association of Wildlife Veterinarians: http://www.aawv.net/.

American Bird Conservancy, P.O. Box 249, The Plains, VA 20198; Phone: 540-253-5780; http://www.abcbirds.org/

American Birding Association, P.O. Box 6599, Colorado Springs, CO 80934; Phone: 719-578-1480; http://www.americanbirding.org/.

American Cetacean Society, P.O. Box 1391, San Pedro, CA 90733-0391; Phone: 310-548-6279; http://www.acsonline.org/.

American Chestnut Foundation, 469 Main St., P.O. Box 4044, Bennington, VT, 05201-4044; Phone: 802-447-0110; http://chestnut.acf.org/.

American Fisheries Society, 5410 Grosvenor Ln., Bethesda, MD 20814; Phone: 301-897-8616; http://www.fisheries.org/.

American Forests, P.O. Box 2000, Washington, DC 20013; Phone: 202-955-4500; http://www.amfor.org/.

American Fund for Alternatives to Animal Research, 175 West 79th St., Suite 16-G, New York, NY 10011; Phone: 212-989-8073; http://www.uiowa.edu/~vpr/research/animalt.htm.

American Museum of Natural History, Central Park West at 79th St., New York, NY 10024-5192; Phone: 212-769-5606; http://www.amnh.org/. *Natural History*, 10 issues/year.

American Oceans Campaign, 600 Pennsylvania Ave., SE, Suite 210, Washington, DC 20003; Phone: 202-544-3526; http://www.americanoceans.org/.

American Ornithologists™ Union, Museum of Natural History, 10th and Constitution, NW, #116, Washington, DC 20560; Phone: 202-357-2051; http://www.aou.org/.

American Rivers, 1025 Vermont Ave., NW, Suite 720, Washington, DC 20005; Phone: 202-347-7550; http://www.americanrivers.org/.

American Society for the Prevention of Cruelty to Animals (ASPCA), 424 East 92nd St., New York, NY 10128; Phone: 212-876-7700; http://www.aspca.org/. Quarterly magazine, *ASPCA Animal Watch*.

American Society of Mammalogists: http://www.mammalsociety.org/.

American Veterinary Medical Association, 1931 N. Meacham Rd., Suite 100, Schaumburg, IL 60173; Phone: 847-925-8070; http://www.avma.org/.

American Zoo and Aquarium Association, Oglesbay Park, Wheeling, WV 26003; Phone: 304-242-2160; http://www.aza.org/.

Amigos del Bosque, Mr. Noe Adalberto Ventura Loyo, 9a Calle 2-23 zona 1, 01001 Guatemala City, Guatemala; Phone: 502-2-21-14-40. Rainforest protection organization.

Ancient Forests International, P.O. Box 1850, Redway, CA 95560; Phone: 707-923-4475; http://www.ancientforests.org/. *News of Old Growth* newsletter.

Animal Legal Defense Fund, 127 Fourth St., Petaluma, CA 94952; Phone: 707-769-7771; http://www.aldf.org/.

Animal Protection Institute, P.O. Box 22505, Sacramento, CA 95822; Phone: 916-447-3085; http://www.api4animals.org/.

Animal Welfare Information Center, US Department of Agriculture, Agricultural Research Service, National Agricultural Library, 10301 Baltimore Ave., 4th Fl., Beltsville, MD 20705-2351; Phone: 301-504-6212; http://www.nal.usda.gov/awic.

Animal Welfare Institute, 900 Pennsylvania Avenue, SE, Washington DC 20003; Phone: 202-337-2332; http://www.awionline.org/. *AWI Quarterly* newsletter; reports and educational materials.

Animals™ Agenda, The, P.O. Box 25881, Baltimore, MD 21224; Phone: 410-675-4566; http://www.animalsagenda.org/.

Ark Trust, Inc., P.O. Box 8191, Universal City, CA 91618-8191; Phone: 818-501-2ARK; http://www.arktrust.org/. Presents Genesis Awards to members of media for films and television programs that promote animal conservation and humane treatment.

Association for Nature fiWolf,fl ul. Gorska 69, 43-376 Godziska, Poland; http://www.most.org.pl/wolf.

Association of Veterinarians for Animal Rights, P.O. Box 208, Davis, CA 95617-0208; Phone: 530-759-8116; http://www.avar.org/.

Atlantic Salmon Federation, International Headquarters, P.O. Box 5200, St. Andrews, New Brunswick E5B 3S8, Canada; Phone: 506-529-1033.

Audubon Naturalist Society, 8940 Jones Mill Rd., Chevy Chase, MD 20815; Phone: 301-652-9188.

Australian Rainforest Conservation Society, 19 Colorado Ave., Bardon Queensland 4065, Australia; Phone: 61-7-3368-1318; http://www.rainforest.org.au/.

Australasian Bat Society: batcall.csu.edu.au/batcall/abs.

Organizations: B

Bat Conservation International, P.O. Box 162603, Austin, TX 78716; Phone: 512-327-9721; http://www.batcon.org/.

Bat Conservation Trust, The, 15 Cloisters House, 8 Battersea Park Rd., London SW8 4BG, England; Phone: 020-7627-2629; http://www.bats.org.uk/.

Beyond Pesticides, 701 E St., SE, #200, Washington, DC 20003; Phone: 202-543-5450; http://www.beyondpesticides.org/.

Biodiversity Resource Center. See California Academy of Sciences. *Pesticides and You* newsletter.

Biogems, project of the Natural Resources Defense Council, 40 West 20th St., New York, NY 10011; Phone: 212-727-2700; http://www.savebiogems.org/.

BirdLife International (formerly the International Council for Bird Preservation),Wellbrook Court, Girton Rd., Cambridge CB3 ONA, United Kingdom; Phone: +44-1-223-277-318. *World Birdwatch*, quarterly newsletter; http://www.birdlife.net/.

Bluewater Network (a project of Earth Island Institute re: ocean conservation and water pollution), 311 California, Suite 510, San Francisco, CA 94104; bluewaternetwork.org.

Bushmeat Crisis Task Force: http://www.bushmeat.org/. Coalition of organizations working to control slaughter of wildlife, especially endangered species such as Chimpanzees, for sale in markets.

Organizations: C

California Academy of Sciences, 55 Concourse Dr., Golden Gate Park, San Francisco, CA 94118-4599; www.calacademy.org/research/library/biodiv/ lists extensive bibliography of regions and species. *California Wild* (formerly *Pacific Discovery*), quarterly magazine published by the Academy by subscription or on newsstands.

Canadian Nature Federation, 1 Nicholas St., Ottawa, Ontario K1N 7B7, Canada; Phone: 1-800-267-4088; http://www.cnf.ca/.

Center for Biological Diversity, P.O. Box 710, Tucson, AZ 85702-0710; Phone: 520-623-5252; http://www.biologicaldiversity.org/.

Center for Captive Chimpanzee Care, P.O. Box 12220, Fort Pierce, FL 34979; Phone: 561-429-0403; http://www.savethechimps.org/.

Center for Coastal Studies, P.O. Box 1036, Provincetown, MA 02657; Phone: 508-487-6115; http://www.coastalstudies.org/. Conducts whale and other marine mammal rescues and research.

Center for Marine Conservation: See The Ocean Conservancy.

Conservation, P.O. Box 299, St. Louis, MO 63166-0299; Phone: 314-577-9450; http://www.mobot.org/cpc.

Center for Safe Energy, Earth Island Institute, 2828 Cherry St., Berkeley, CA 94705; Phone: 510-883-1177; http://www.earthisland.org/cse.

Center for Science in the Public Interest, 1875 Connecticut Ave., NW, Suite 300, Washington, DC 20009; Phone: 202-332-9110; http://www.cspinet.org/.

Center for the Study of Tropical Birds, 218 Conway Dr., San Antonio, TX 78209-1716; Phone: 1-800-858-CSTB; http://www.cstbinc.org/.

Center for Whale Research, 1359 Smugglers Cove, P.O. Box 1577, Friday Harbor, WA 98250-0157; Phone: 360-378-5835; http://www.whaleresearch.com/.

Cetacean Society International, P.O. Box 953, Georgetown, CT 06829; Phone: 203-431-1606; http://www.csiwhalesalive.org/.

Chesapeake Bay Foundation, The, Philip Merrill Environmental Center, 6 Herndon Ave., Annapolis, MD 21403; Phone: 1-888-SAVE-BAY; http://www.savethebay.cbf.org/.

Chihuahuan Desert Research Institute, P.O. Box 905, Ft. Davis, TX 79734; Phone: 915-364-2499; http://www.cdri.org/.

Chimp Haven, Inc., 710 Spring St., Shreveport, LA 71101; Phone: 1-888-98CHIMP; http://www.chimphaven.org/.

Clean Water Action, 4455 Connecticut Ave., NW, Suite A-300, Washington, DC 20003-2328; Phone: 202-895-0420; http://www.cleanwateraction.org/.

Clean Water Network, 1200 New York Ave., NW, Washington, DC 20003; Phone: 202-289-2395; http://www.cwn.org/.

College and University home pages: http://www.utexas.edu/world/univ.

Conservation Foundation (part of World Wildlife Fund), 1250 - 24th St., NW, P.O. Box 97180, Washington, DC 20090-7180; Phone: 202-293-4800; http://www.worldwildlife.org/. United Kingdom: Panda House, Weyside Park, Godalming, Surrey GU7 1XR, United Kingdom; Phone: 01483 426444; http://www.wwf-uk.org/.

Conservation International, 1919 M St., Suite 600, Washington, DC 20036; Phone: 1-800-406-2306; http://www.conservation.org/.

Cornell Lab of Ornithology, 159 Sapsucker Woods Rd., Ithaca, NY 14850-1998; Phone: 1-800-843-BIRD; http://www.birds.cornell.edu/. *Living Bird* journal.

Cousteau Society, The, 870 Greenbrier Cir., Suite 402, Chesapeake, VA 23320-2641; http://www.cousteausociety.org/; Phone: 1-800-441-4395.

Cultural Survival, 215 Prospect St., E., Cambridge, MA 02138; Phone: 617-441-5417; http://www.culturalsurvival.org/.

Organizations: D

Defenders of Wildlife, 1101 - 14th St., NW, Suite 1400, Washington, DC 20005; Phone: 202-682-9400; http://www.defenders.org/. *Defenders*, bimonthly-monthly magazine.

Defensores de la Naturaleza, 19 Avenida fiBfl 0-83, Zona 15, Vista Hermosa II, Guatemala 01015; Phone: 502-369-5167; eco-web.com/register/02222.html.

Desert Tortoise Preservation Committee, 4067 Mission Inn Ave., Riverside CA 92501; Phone: 909-683-3872; http://www.tortoise-tracks.org/.

Dian Fossey Gorilla Fund International, The, 800 Cherokee Ave., SE, Atlanta, GA 30315-1440; Phone: 1-800-851-0203; http://www.gorillafund.org/.

Dolphin Project, The, P.O. Box 224, Coconut Grove, FL 33233; Phone: 305-668-1619. Founder, Richard O™Barry, works to stop capture of wild dolphins and to rehabilitate and release captive dolphins.

Durrell Wildlife Conservation Trust (formerly the Jersey Wildlife Preservation Trust), Les Augres Manor, Trinity, Jersey, Channel Islands JE3 5BP, British Isles; Phone: +44(0)1534 860000; http://www.durrellwildlife.org/. *The Dodo*, annual journal; *The Dodo Dispatch* for young people.

Organizations: E

E. The Environmental Magazine, P.O. Box 2047, Marion, OH 43305-2047; Phone: 815-734-1242; http://www.emagazine.com/. Bimonthly magazine published by Earth Action Network, Inc., Norwalk, CT 06851.

Eagle Nature Foundation, The, 300 E. Hickory St., Apple River, IL 61001; Phone: 815-594-2305; http://www.eaglenature.net/.

Earth First!, P.O. Box 3023, Tucson, AZ 85702; Phone: 520-620-6900; http://www.earthfirstjournal.org/. *Earth First!* newsletter.

Earth Island Institute, 300 Broadway, Suite 28, San Francisco, CA 94133; Phone: 415-788-3666; http://www.earthisland.org/. *Earth Island Journal*, quarterly magazine.

Earthjustice Legal Defense Fund (formerly Sierra Club Legal Defense Fund), 426 - 17th St., 6th Fl., Oakland, CA 94612-2820; Phone: 510-550-6700; http://www.earthjustice.org/. *In Brief*, newsletter

Earthwatch Australia, 126 Bank St., South Melbourne, Victoria 3305, Australia; Phone: 61-3-9682-6828; earthwatch.org/australia/au.html.

Earthwatch Institute, 3 Clock Tower Pl., Suite 100, P.O. Box 75, Maynard, MA 01754-9928; Phone: 1-800-776-0188; http://www.earthwatch.org/.

Eco Travel Center: www.ecotour.org.

Ecological Society of America, 1707 H St., NW, Suite 400, Washington, DC 20006; Phone: 202-833-8773; http://www.esa.org/.

Ecology Fund, 216 E. Huron, Ann Arbor, MI 48104; Phone: 734-213-7777; http://www.ecologyfund.com/. Save open space by clicking on to your choice of threatened animals; e.g., parrot habitat in Mexico, bear habitat in Canada, or around the world.

Ecotourism Society, The, P.O. Box 668, Burlington, VT 05402; Phone: 802-651-9818; http://www.ecotourism.org/.

Elm Research Institute, Elm St., P.O. Box 150, Westmoreland, NH 03467; Phone: 1-800-FOR-ELMS; http://www.forelms.org/. Members receive press releases and can apply for free elm trees; information on projects and saving diseased elms.

Endangered Species Project, 1836 - 14th St., NW, Washington, DC 20009; Fort Mason Center, E-205, San Francisco, CA 94123; Phone: 415-921-3140.

Environmental Action, 6930 Carroll Ave., Suite 600, Takoma Park, MD 20912; Phone: 301-891-1100.

Environmental Defense (formerly Environmental Defense Fund), 257 Park Ave., S., New York, NY 10010; Phone: 212-505-2100; http://www.environmentaldefense.org/.

Environmental Education Associates, P.O. Box 1802, San Anselmo, CA 94979; Phone: 415-281-3388. Integrates environmental material into regular curriculum at school.

Environmental Law Institute, 1616 P St., NW, Suite 200, Washington, DC 20036; Phone: 202-939-3800; http://www.eli.org/.

Environmental Media Services, 1320 - 18th St., NW, 2nd Fl., Washington, DC 20036; Phone: 202-463-6670; http://www.ems.org/.

Environmental News Network, 2020 Milvia, Suite 411, Berkeley, CA 94704; http://www.enn.com/index.asp. Lists sites offering free donations to environmental organizations.

Environmental Resource Center, P.O. Box 819, Ketchum, ID 83340; Phone: 208-726-4337.

Environmental Working Group, 1718 Connecticut Ave., NW, Suite 600, Washington, DC 20009; Phone: 202-667-6982; http://www.ewg.org/.

Organizations: F

Fauna and Flora International, Great Eastern House, Tenison Rd., Cambridge CB1 2TT, United Kingdom; Phone: 44 1223 57 1000; http://www.fauna-flora.org/. *Oryx, The International Journal of Conservation*.

Forests Forever, 973 Market St., Suite 450, San Francisco, CA 94103; Phone: 415-974-3636; http://www.forestsforever.org/.

Forest Service Employees for Environmental Ethics (FSEEE), P.O. Box 11615, Eugene, OR 97440; Phone: 541-484-2692; http://www.fseee.org/.

Forest Stewardship Council, 1155 - 30th St., NW, Suite 300, Washington, DC 20007; Phone: 202-342-6589; http://www.fscus.org/.

Fossil Rim Wildlife Center, P.O. Box 2189, Glen Rose, TX 76043; Phone: 254-897-2960; http://www.fossilrim.org/. Breeds endangered wildlife.

Friends of Animals, 777 Post Rd., Suite 205, Darien, CT 06820; Phone: 203-656-1522; http://www.friendsofanimals.org/. *Action Line*, quarterly magazine.

Friends of the Earth, 1021 Vermont Ave., NW, Washington, DC 20005; Phone: 202-783-7400; http://www.foe.org/.

Friends of the Everglades, 7800 Red Rd., Suite 215-K, Miami, FL 33143; Phone: 305-669-0858; http://www.everglades.org/.

Friends of the Sea Otter, 125 Ocean View Blvd., #204, Pacific Grove, CA 93950; Phone: 831-373-2747; http://www.seaotters.org/. *Sea Otter Raft*, newsletter.

Fund for Animals, 200 West 57th St., New York, NY 10019; Phone: 212-246-2096; http://www.fund.org/.

Fundacao Botanica Margaret Mee, Av. General Justo 171/8e Andar, CEP 2222-1-090, Centro, Rio de Janeiro, RJ Brazil; Phone: 55-21-533-1486.

Fundacao Vitoria Amazonica, Rua R/S Quadra Q, Casa 7, Conjunto Morado do Sol, Manaus, Amazonas 69060-080, Brazil; Phone: 55-92-642-1336.

Organizations: G

Gaia Foundation, C/O Redbridge Community Development Agency, South Ilford Community Centre, Eton Rd., Ilford, Essex 1G1 2UE, United Kingdom; Phone: 44-20-8554-9389; http://www.foundation-gaia.org/.

Global Rivers Environmental Education Network, C/O Earth Force, 1908 Mount Vernon, 2nd Fl., Alexandria, VA 22301; Phone: 703-299-9400; http://www.earthforce.org/green/

Gopher Tortoise Council, C/O Florida Museum of Natural History, University of Florida, P.O. Box 17800, Gainesville, FL 32611; http://www.gophertortoisecouncil.org/. *Tortoise Burrow* and *The Bulletin*, newsletters.

Gorilla Foundation, The, P.O. Box 620530, Woodside, CA 94062; Phone: 1-800-634-6273; http://www.koko.org/. *Gorilla*, quarterly journal.

Great Ape Project International, The, P.O. Box 19492, Portland, OR 97280-0492; http://www.greatapeproject.org/.

Great Bear Foundation, P.O. Box 9383, Missoula, MT 59807; Phone: 406-829-9378; http://www.greatbear.org/. *Bear News*, quarterly newsletter.

Greater Yellowstone Coalition, P.O. Box 1874, 13 S. Wilson, Suite 2, Bozeman, MT 59771; Phone: 406-586-1593; http://www.greateryellowstone.org/.

Greenpeace International, Keizersgracht 176, 1016 DW Amsterdam, The Netherlands; Phone: 31 20 523 6222; http://www.greenpeace.org/.

Greenpeace USA, 702 H St., NW, Suite 300, Washington, DC 20001; Phone: 1-800-326-0959; http://www.greenpeaceusa.org/.

The Greens. Green Party USA, P.O. Box 30208, Kansas City, MO 64112; Phone: 816-931-9366; http://www.greenparty.org/. Grassroots political party committed to ecological values and respect for nature and wildlife.

Organizations: H - I

Humane Society of the United States, 2100 L St., NW, Washington, DC 20037; Phone: 202-452-1100; http://www.hsus.org/. *Humane Society News*, quarterly magazine; *Allanimals*, quarterly magazine.

International Bee Research Association, 18 North Rd., Cardiff, CF10 3DT, United Kingdom; Phone: +44 (0) 2920 372409; http://www.cfac.uk/ibra.

International Bird Rescue Research Center, 4369 Cordelia Rd., Suisun, CA 94585; http://www.ibrrc.org/; Phone: 707-207-0380.

International Crane Foundation, P.O. Box 447, Baraboo, WI 53911; Phone: 608-356-9462; http://www.savingcranes.org/. *ICF Bugle*, newsletter.

International Fund for Animal Welfare, P.O. Box 193, Yarmouth Port, MA 02675; Phone: 508-744-2000 or 1-800-932-IFAW; http://www.ifaw.org/.

International Rivers Network, 1847 Berkeley Way, Berkeley, CA 94703; Phone: 510-848-1155; http://www.irn.org/.

International Snow Leopard Trust, 4649 Sunnyside Ave., N., Suite 325, Seattle, WA 98103; Phone 206-632-2421; http://www.snowleopard.org/.

IUCN (International Union for the Conservation of Nature and Natural Resources), Rue Mauverney 28, CH-1196 Gland, Switzerland; www.iucn.org. Publications Unit: 219c Huntingdon Rd., Cambridge CB4 5PP, United Kingdom; Phone: 44-1223-277894. *Red Lists of Threatened Animals*: http://www.redlist.org/. IUCN publications catalog available at Publications Unit address. Some publications available in the United States from Island Press (1-800-828-1302).

International Wildlife Coalition, 70 E. Falmouth Hwy., East Falmouth, MA 02536; Phone: 508-548-8328; http://www.iwc.org/.

International Wolf Center, 1396 Hwy. 169, Ely, MN 55731-8129; Phone: 218-365-4695; http://www.wolf.org/.

Organizations: J - K - L
Jane Goodall Institute, The, P.O. Box 14890, Silver Spring, MD 20910-4890; Phone: 301-565-0086; http://www.janegoodall.org/. Primate protection and environmental education, with emphasis on chimpanzees.

Jersey Wildlife Preservation Trust: See Durrell Conservation Trust (United Kingdom) and Wildlife Trust (US).

League of Conservation Voters, 1920 L St., NW, Suite 800, Washington, DC 20016; Phone: 202-785-8683; http://www.lcv.org/.

Loon Preservation Committee, P.O. Box 604, Moultonborough, NH 03254; Phone: 603-476-5666; http://www.loon.org/.

Organizations: M
Marine Education Center of Cape Ann, P.O. Box 3015, Gloucester, MA 01930; Phone: 415-289-7325; http://www.cape-ann.com/. Rescues and rehabilitates injured and stranded marine mammals.

Marine Mammal Center, The, Marin Headlands, 1065 Fort Cronkhite, Sausalito, CA 94965; Phone: 415-289-7325; http://www.tmmc.org/. Rescues and rehabilitates injured and stranded marine mammals.

Massachusetts Audubon Society, 208 South Great Rd., Lincoln, MA 01773; Phone: 781-259-9661; http://www.massaudubon.org/. *Sanctuary*, bimonthly magazine.

Missouri Botanical Garden, St. Louis, MO 63101; Phone: 314-577-5100; http://www.mobot.org/. Information on endangered plants, including tropical forest species.

Mountain Gorilla Conservation Fund, P.O. Box 2211, Englewood, CO 80150-2211; Phone: 303-781-3484; http://www.mountaingorillaconservationfund.org/ and http://www.gorilla100.com/.

Museums in the United States: http://www.museumca.org/usa.

Organizations: N
National Audubon Society, 700 Broadway, New York, NY 10003; Phone: 212-979-3000; http://www.audubon.org/. *Audubon*, bimonthly magazine available by subscription and on newsstands.

National Coalition for Marine Conservation, 3 N. King St., Leesburg, VA 20176; Phone: 703-777-0037; http://www.savethefish.org/.

National Foundation to Protect America™s Eagles, Save the Eagle Project, P.O. Box 120206, Nashville, TN 37212; Phone: 615-847-4171.

National Geographic Society, 1145 - 17th St., NW, Washington, DC 20036; Phone: 202-857-7000; http://www.nationalgeographic.com/. *National Geographic*, monthly publication available by subscription and on newsstands. *World Magazine*, publication for young people, includes articles on endangered species and habitat.

National Parks and Conservation Association, 1300 - 19th St., NW, Suite 300, Washington, DC 20036; Phone: 1-800-628-7275; http://www.npca.org/. *National Parks* magazine for members.

National Wildflower Research Center, Lady Bird Johnson Wildflower Center, 4801 LaCrosse Ave., P.O. Box 149187, Austin, TX 78739; Phone: 512-292-4200; http://www.wildflower.org/. *Wildflower*, bimonthly newsletter for members.

National Wildlife Rehabilitators Association, 14 N. Seventh Ave., St. Cloud, MN 56303-4766; Phone: 320-259-4-86; http://www.nwrawildlife.org/.

Native Forest Council, P.O. Box 2190, Eugene, OR 97402; Phone: 541-688-2600; http://www.forestcouncil.org/.

Native Seeds/SEARCH, 526 N. Fourth Ave., Tucson, AZ 85706; Phone: 520-622-5561; http://www.nativeseeds.org/. Distributes seeds of indigenous North American plants. *The Seedhead News*.

Natural Resources Defense Council, 40 West 20th St., New York, NY 10011; Phone: 212-727-2700; http://www.nrdc.org/.

Nature Conservancy, The, 4245 N. Fairfax Dr., Suite 100, Arlington, VA 22203-1606; Phone: 1-800-628-6860; nature.org. *Nature Conservancy*.

Negative Population Growth, 1717 Massachusetts Ave., NW, Suite 101, Washington, DC 20036; Phone: 202-667-8950; http://www.npg.org/.

New England Aquarium, Central Wharf, Boston, MA 02110; Phone: 617-973-5200; http://www.neaq.org/. Programs include rescue of marine mammals and sea turtles and rehabilitation for release.

New England Wild Flower Society, 180 Hemenway Rd., Framingham, MA 01701-2699; http://www.newfs.org/; Phone: 508-877-7630. *New England Wild Flowers*, magazine published three times a year. Web site includes *Directory of Native Plant Societies*.

New York Times Science Times: http://www.nytimes.com/.

North American Bluebird Society, The Wilderness Center, P.O. Box 244, Wilmot, OH 44689-5511; http://www.nabluebirdsociety.org/; Phone: 330-359-5511. *Bluebird*, newsletter.

North American Butterfly Association, 4 Delaware Rd., Morristown, NJ 07960; www.naba.org. *American Butterflies* and *Butterfly Gardener*.

North American Loon Fund, P.O. Box 68, Mt. Pleasant, MI 44804; facstaff.uww.edu/wentzl/nalf/analfhomepage.html; Phone: 989-772-9611.

North American Native Fishes Association, 1107 Argonne Dr., Baltimore, MD 21218; http://www.nanfa.org/.

Organizations: O

Ocean Conservancy, The (formerly Center for Marine Conservation), 1725 DeSales St., NW, Suite 500, Washington, DC 20036; http://www.oceanconservancy.org/; Phone: 202-429-5609. *The Blue Planet*, quarterly magazine.

Ocean Realm (quarterly magazine), 4067 Broadway, San Antonio, TX 78209; http://www.oceanrealm.net/; Phone: 210-824-8099.

Oil Spill Intelligence Report: http://www.cutter.com/.

Orangutan Foundation International, 822 S. Wellesley Ave., Los Angeles, CA 90049; http://www.orangutan.org/; Phone: 1-800-ORANGUTAN. Founder, Birute Galdikas, directs rescue and rehabilitation of orphaned and confiscated orangutans on Borneo and conducts scientific research on the species™ ecology and conservation.

Orion Society, 187 Main St., Great Barrington, MA 01230; oriononline.org; Phone: 1-800-909-6568 or 413-528-4422. *Orion. People and Nature* quarterly magazine.

Organizations: P

People for the Ethical Treatment of Animals (PETA), 501 Front St., Norfolk, VA 23510; http://www.peta.org/; Phone: 757-622-7382. *PETA™s Animal Times*, quarterly magazine.

Peregrine Fund, The, 5666 W. Flying Hawk Ln., Boise, ID 83709; http://www.peregrinefund.org/; Phone: 208-362-3716.

Performing Animal Welfare Society (PAWS), P.O. Box 849, Galt, CA 95632; http://www.pawsweb.org/; Phone: 866-FOUR-PAWS; 209-745-2606. Fights cruelty against elephants and big cats in zoos and circuses and runs an animal sanctuary.

Pesticide Action Network, 49 Powell St., Suite 500, San Francisco, CA 94102; http://www.panna.org/; Phone: 415-981-1771.

Pew Wilderness Center, Protecting America™s Wilderness and Natural Heritage, 122 C St., NW, Suite 240, Washington, DC 20001; http://www.pewwildernesscenter.org/; Phone: 202-544-3691.

Planned Parenthood Federation of America: http://www.plannedparenthood.org/. State and regional offices are listed along with publications and member services.

Population Action International, 1300 - 19th St., NW, 2nd Fl., Washington, DC 20036; http://www.populationaction.org/; Phone: 202-557-3400. Web site lists many publications.

Population Communications international, 777 United Nations Plaza, New York, NY 10017-3521; http://www.population.org/; Phone: 212-687-3366.

Population Connection (formerly Zero Population Growth), 1400 - 16th St., NW, Suite 320, Washington, DC 20036; http://www.populationconnection.org/; Phone: 202-332-2200.

Population Institute, The, 107 Second Ave., NE, Washington, DC 20002; http://www.populationinstitute.org/; Phone: 202-544-3300.

Predator Conservation Alliance, P.O. Box 6733, Bozeman MT 59771; http://www.predatorconservation.org/; Phone: 406-587-3389. *The Home Range*, quarterly newsletter.

Primarily Primates, P.O. Box 207, San Antonio, TX 78291-0207; http://www.primarilyprimates.org/; Phone: 830-755-4616.

Pro Natura USA, 8123 Heatherton Ln., #104, Vienna, VA 22180; Phone: 703-641-5900.

Pro Natura International, 61, Green Ridges, Headington, Oxford OX3 8PL, United Kingdom.

Pro Natura Brazil, Ave., Beira Mar 406, Sala 708/709, Castelo, Rio de Janeiro 22021.060, Brazil.

Public Citizen and Public Citizen Health Group, 1600 - 20th St., NW, Washington, DC 20009; http://www.citizen.org/; Phone: 202-588-1000.

Public Interest Research Group (PIRG), 218 D St., SE, Washington, DC 20003; http://www.pirg.org/; Phone: 202-546-9707.

Organizations: Q Œ R

Rainforest Action Network, 221 Pine St., Suite 500, San Francisco, CA 94104; http://www.ran.org/; Phone: 415-398-4404. *World Rainforest Report*, newsletter for members. Rainforest teacher™s packet available.

Rainforest Alliance, 65 Bleecker St., New York, NY 10012; http://www.rainforestalliance.org/; Phone: 212-677-1900.

Rainforest Foundation US, The, 270 Lafayette St., Suite 1107, New York, NY 10012; Phone: 212-431-9098. Headquarters: Suite A5, City Cloisters, 196 Old St., London EC1V 9FR, United Kingdom; Phone: +44 (0) 20-7251-6345. Organization founded by rock artist Sting to promote conservation of rainforests and their native peoples.

Rainforest Relief, P.O. Box 150566, Brooklyn, NY 11215; http://www.rainforestrelief.org/; Phone: 718-398-3760. *Raindrops, Rainforest Relief Reports*, newsletter.

Raptor Center, The, Gabbert Raptor Building, 1920 Fitch Ave., St. Paul, MN 55108; http://www.raptor.cvm.umn.edu/; Phone: 612-624-4745. *Raptor Release*, newsletter.

RARE Center for Tropical Conservation, 1840 Wilson Blvd., Suite 402, Arlington, VA 22201-3000; http://www.rarecenter.org/; Phone: 703-522-5070. *RARE Center News*, newsletter.

Riverkeeper, P.O. Box 130, Garrison, NY 10524; http://www.riverkeeper.org/; Phone: 845-424-4149. Lists regional organizations specializing in particular rivers.

Rocky Mountain Institute, 1739 Snowmass Creek Rd., Snowmass, CO 81654-9199; Phone: 970-927-2851. Environmentally friendly sources of energy, architecture, transportation, energy efficiency.

Organizations: S

Save America™s Forests, 4 Library Ct., SE, Washington, DC 20003; http://www.saveamericasforests.org/; Phone:

202-544-9219. *Save America™s Forests Magazine*

Save the Manatee Club, 500 N. Maitland Ave., Maitland, FL 32751; http://www.savethemanatee.org/; Phone: 407-539-0990.

Save the Redwoods League, 114 Sansome St., Room 1200, San Francisco, CA 94104-3823; http://www.savetheredwoods.org/; Phone: 415-362-2352.

Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Dr., La Jolla, CA 92093; www.sio.ucsd.edu/ ; Phone: 858-534-3624.

Sea Shepherd Conservation Society, 22774 Pacific Coast Hwy., Malibu, CA 90265; www.seashepherd.org; Phone: 310-456-1141.
Sea Turtle Restoration Project, P.O. Box 400, Forest Knolls, CA 94931; http://www.seaturtles.org/ ; Phone: 415-488-0370. Free catalog.

SeaWeb, 1731 Connecticut Ave., NW, 4th Fl., Washington, DC 20009; http://www.seaweb.org/ ; Phone: 202-483-9570.

Sierra Club, 85 Second St., 2nd Fl., San Francisco, CA 94105-3441; http://www.sierraclub.org/ ; Phone: 415-977-5500. *Sierra* magazine by subscription and on newsstands.

Sierra Club Legal Defense Fund: See Earthjustice Legal Defense Fund.

Sierra Club Student Coalition, P.O. Box 2402, Providence, RI 02906; http://www.ssc.org/ ; Phone: 1-888-JOIN-SSC.

Society for Animal Protective Legislation, P.O. Box 3719, Georgetown Station, Washington, DC 20007; http://www.saplonline.org/ ; Phone: 202-337-2334. This is the Animal Welfare Institute™s companion organization for legislative issues.

Society for Conservation Biology, 4245 N. Fairfax Dr., Arlington, VA 22203; http://www.conbio.org/ ; Phone: 703-276-2384. *Conservation Biology*, quarterly journal with articles by scientists on conservation, endangered species and related topics; and *Conservation Biology in Practice*.

Society for the Preservation of Birds of Prey, P.O. Box 66070, Los Angeles, CA 90066; Phone: 310-840-2322. *The Raptor Report*, newsletter.

Society of Tympanuchus Cupido Pinnatus, Ltd. (Society of the Greater Prairie Chicken), Stone Ridge II, Suite 280, Stone Ridge Dr., Waukeha, WI 53188; Phone: 414-523-3600. *Boom*, newsletter.

Solar Energy International, P.O. Box 715, Carbondale, CO 81623-0715; http://www.solarenergy.org/ ; Phone: 970-963-8855. *Home Power*, magazine.

Southern Environmental Law Center, 201 W. Main St., Suite 14, Charlottesville, VA 22902-5065; http://www.selcga.org/ ; Phone: 434-977-4090.

Stanford University Center for Conservation Biology: www.stanford.edu/group/CCB .

Student Environmental Action Coalition, National Office, P.O. Box 31909, Philadelphia, PA 19104-0609; http://www.seac.org/ ; Phone: 215-222-4711.

Suncoast Seabird Sanctuary, Inc., 18328 Gulf Blvd., Indian Shores, FL 33785; http://www.seabirdsanctuary.org/ ; Phone: 727-391-6211. Treats and rehabilitates injured seabirds, especially those who have swallowed fish hooks or have become entangled in fishing lines.

Survival International, 6 Charterhouse Bldg., London EC1M 7ET, United Kingdom; http://www.survival-international.org/ ; Phone: 00-44-20-7687-8700.

Organizations: T

Tiger Trust, The: www.fontayne.com/tigertrust/ . *Tiger News*, biannual journal.

TRAFFIC International, 219c Huntingdon Rd., Cambridge CB3 ODL, United Kingdom; http://www.traffic.org/ ; Phone: (44) 1-223-27723. *TRAFFIC Bulletin*, quarterly publication on wildlife trade.

TRAFFIC USA, 1250 - 24th St, NW, Washington, DC 20037; www.traffic.org/25/network6.htm ; Phone: 202-293-4800. Newsletter on wildlife trade; affiliated with World Wildlife Fund.

Trumpeter Swan Society, The, 3800 County Road 24, Maple Plain, MN 55359; www.taiga.net/swans/ ; Phone: 763-476-4663. *Bulletin of the Trumpeter Swan Society*.

Trust for Public Lane, 116 New Montgomery St., 4th Fl., San Francisco, CA 94105; http://www.tpl.org/ ; Phone: 415-495-4014.

Organizations: U Œ V Œ W

Union of Concerned Scientists, 2 Brattle Square, Cambridge, MA 02238; http://www.ucsusa.org/ ; Phone: 617-547-5552.

WhaleNet, 200 The Riverway, Boston, MA 02215; www.whalenet.org or http://www.wheelock.edu/ .

Whooping Crane Conservation Association, 1393 Henderson Hwy., Breaux Bridge, LA 70517; http://www.whoopingcrane.com/ .

Wild Canid Survival and Research Center, Washington University™s Tyson Research Center, P.O. Box 760, Eureka, MO 63025; http://www.wolfsanctuary.org/ ; Phone: 636-938-5900. *Wild Canid Center Review*.

Wild Sentry, The Northern Rockies Ambassador Wolf Program, Inc., P.O. Box 172, Hamilton, MT 59840; www.bitterroot.net/wild ; Phone: 406-363-7291.

Wilderness Society, The, 1615 M St., NW, Washington, DC 20016; http://www.wilderness.org/ ; Phone: 1-800-THE-WILD. *Wilderness*, magazine.

Wildlife Connection, The, P.O. Box 719, Jasper, AR 72641; Phone: 502-524-2396. Education and rehabilitation.

Wildlife Conservation Society, Bronx Zoo/Wildlife Conservation Park, 2300 Southern Blvd., Bronx, NY 10460; http://www.bronxzoo.com/ ; Phone: 718-220-5100. Virtual tour and information on the programs of the Wildlife

Conservation Society to preserve rainforests in the Congo; saving endangered species. *Wildlife Conservation*, bimonthly magazine by subscription and on newsstands; http://www.wildlifeconservation.org/ .

Wildlife Society, The, 5410 Grosvenor Ln., Bethesda, MD 20814; www.wildlife.org; Phone: 301-897-9770.

Wildlife Trust (formerly US partner of the Jersey Wildlife Preservation Trust), 61 Route 9W, Palisades, NY 10964-8000; http://www.wildlifetrust.org/ ; Phone: 845-365-8337. *On the Edge*, a quarterly magazine for members.

Wolf Education and Research Center, The, P.O. Box 217, Winchester, ID 83555; http://www.wolfcenter.org/ ; Phone: 208-924-6960.

Woods Hole Oceanographic Institution, 360 Woods Hole Rd., Woods Hole, MA 02543-1541; http://www.whoi.edu/ ; Phone: 508-548-2219.

World Bird Sanctuary, P.O. Box 270270, St. Louis, MO 63127; http://www.worldbirdsanctuary.org/ ; Phone: 636-861-3225. Propagation and rehabilitation of exotic parrots and other birds.

World Conservation Monitoring Centre, 219c Huntingdon Rd., Cambridge CB3 0DL, United Kingdom; http://www.unep-wcmc.org/ ; Phone: 44 (0) 1223-277314. Affiliated with the International Union for the Conservation of Nature (IUCN) and World Wildlife Fund, it compiles information on endangered species and wildlife trade.

World Conservation Union: See International Union for the Conservation of Nature and Natural Resources (IUCN).

World Rainforest Movement, P.O. Box 1539, Montevideo 11000, Uruguay; www.chasque.apc.org/item ; Phone: +598-2-419-6292.
World Resources Institute, 10 G St., NE, Washington, DC 20002; www.wri.org; Phone: 202-729-7600.

World Society for the Protection of Animals (WSPA) Headquarters: 89 Albert Embankment, London SE1 7TP, United Kingdom; Phone: 44 (0) 20-7587-5000.
US: 34 Deloss St., Framingham, MA 01702; http://www.wspa-americas.org/ ; Phone: 508-879-8350. *Animals International* and *The Protector*, newsletters.

World Species List (many endangered species lists): www.envirolink.org/species .

World Wildlife Fund US, 1250 - 24th St., NW, P.O. Box 97180, Washington, DC 20090-7180; http://www.wwf.org/ ; Phone: 202-293-4800. *Focus*, newsletter; *Living Planet*, quarterly magazine.

Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC 20036-1904; http://www.worldwatch.org/ ; Phone: 202-452-1999. *State of the World* and *Worldwatch*.

Worldwide Fund for Nature, Avenue du Mont-Blanc, 1196 Gland, Switzerland; http://www.panda.org/ ; Phone: +41-22-364-91-11.

Organizations: X Œ Y - Z
Yellowstone Ecosystem Studies, P.O. Box 6640, Bozeman, MT 59771; www.c-t-g.com/yellowstone ; Phone:

406-587-7558.

Xerces Society, 4828 SE Hawthorne Blvd., Portland, OR 97215-3252; http://www.xerces.org/ ; Phone: 503-232-6639. Newsletter concerning the preservation of butterflies and other invertebrates.

Zero Population Growth: See Population Connection.

Teachers' Aids and Educational Materials

Teachers' Aids
The American Biology Teacher. Published by the National Association of Biology Teachers, 12030 Sunrise Valley Dr., Reston, VA 20191; www.nabt.org; Phone: 1-800-406-0775. Although not primarily concerned with endangered species, this magazine occasionally has information on this subject.

Bullfrog Films™ catalog includes an extensive collection of educational films on the environment and wildlife, many of which are thought provoking and could serve as the basis for discussion. The catalog lists recommended grade levels and awards, accreditation and other background information on each film along with descriptions of the content. Some of the films are reviewed in the video section. www.bullfrogfilms.com; Phone: 1-800-543-3764.

Discovery Channel School. fiDiscovery Channel School K-12 Catalogfl lists materials, such as CD-ROMs and videos, which are packaged together. For example, the Insects packet includes a CD-ROM, a student resource book, fiInsect Files,fl a Teachers™ A-Z Resource Guide on Insects, and an Internet site featuring electron microscope images of insects and fiB-Eye: The World Through the Eyes of a Beefl to show what a flower looks like to a bee. Other packets with CD-ROMs, teachers™ guides and student resource books include: fiPlants,fl fiReptiles,fl fiFish and Amphibians,fl fiInvertebrates,fl fiProtists and Fungi,fl fi Mammals,fl fiBirds,fl fiEvolutionfl and fiEcology.fl The latter title™s Internet link features suggestions on projects to save beaches, a global warming debate about coral reefs, and fiEarth Today.fl Each CD-ROM contains a long video as well as library searches of references, a digital lab and instructions for presentations of slides, text and sound effects to be created by the students. Among the selections in the fiEarth Sciencefl CD-ROM bundle is fiConservation of Natural Resources.fl The latter CD-ROM is also offered in a bundle along with a student resource book, a teacher™s guide and Internet links. Videos geared toward school classes have themes divided into segments. Titles for grades 6 to 12 include: fiFinite Oceansfl on the limits of oceans to absorb pollutants and provide resources; fiCoral Reefsfl explores the Red Sea, an extremely diverse coral ecosystem; fiUnderstanding Oceansfl explains their movements, tides, endangered creatures and experts; fiWater: To the Last Dropfl investigates the contamination and misuse that threatens the limited supplies of freshwater upon which we depend; www.discoveryschool.com.

Conserving Earth™s Biodiversity by Edward O. Wilson and Dan L. Perlman, 1999. Island Press, Covelo, CA (interactive CD-ROM teaching conservation biology and environmental science). Teachers can register for an examination copy and view a demo at: www.islandpress.org/wilsoncd. Senior author is Harvard University professor, author of *The Diversity of Life* and editor of *Biodiversity*, key books on the subject.

Earthwatch. This bimonthly periodical, published by Earthwatch, is available by subscription and is sold by many newsstands. Earthwatch sponsors research projects by scientists. Contributors, scholarship and fellowship students may accompany scientists on their expeditions. Projects have included studies of threatened plants and animals and their disappearing habitats in Australia, Brazil and Thailand; endangered sea turtle ecology in Baja California, Mexico; and Florida Manatees. A typical project is carried out by a scientist affiliated with a well-known university or institution. Volunteers pay to assist the scientists by making observations, taking photographs and performing miscellaneous duties for a period of about two weeks. Active participation in the study depends on the health, interests and abilities of the volunteer. Many teachers go on expeditions, taking copious notes and photos, and use the experience as a teaching outline for courses. Students may also be sponsored by their class or family. Volunteers must be 16 years or older. For those unable to participate in research trips, project briefings are available for $15 each, written by the scientists heading each project, with background information and results as available. There are scholarships and fellowships offered to selected applicants. Earthwatch Institute, 3 Clock Tower Place, Suite 100, P.O. Box 75, Maynard, MA 01754-9928; Phone: 1-800-776-0188; www.earthwatch.org has more than 5,000 pages of background information on projects, a global classroom, an education site, and a virtual expedition. The site has won more than 25 awards for excellence.

Endangered Means There™s Still Time This free US Fish and Wildlife Service brochure explains the basic causes endangering species. The brochures, fiPlacing Animals and Plants on the List of Endangered and Threatened Speciesfl and fiESA Basicsfl explain the listing process, critical habitat and other facets of the US Endangered Species Act. fiWhy Save Endangered Species?fl presents strong arguments for the preservation of biodiversity as it benefits human health and agriculture and tells how animals can be barometers of environmental quality, warning us of the dangers of pesticides, for example. Other brochures include profiles of the Mexican Wolf, Red Wolf, Whooping Crane and others. fiConserving Borderline Species, A Partnership between the United States and Canadafl is a report describing the cooperative programs that have helped Whooping Cranes, Swift Foxes, Black-footed Ferrets and other wildlife and plants that inhabit both sides of the Canada/US border region. A poster entitled fiThe Road to Recoveryfl illustrates some of the species that, because of the Endangered Species Act, have increased in numbers from Near-extinction: the Grizzly Bear, Bald Eagle, Lange™s Metalmark Butterfly, Gray Whale and Greenback Cutthroat Trout. By calling the Publications Unit of the US Fish and Wildlife Service (304-876-7203) or the Office of Endangered Species, one can also request fact sheets on a selected number of US endangered species and copies of US Fish and Wildlife Service publications (USFWS, 4401 N. Fairfax Dr., Arlington, VA 22203; www.fws.gov/). Further information on US endangered species is available from www.natureserve.org, a private database providing legal status and general information on all species listed by The Nature Conservancy as Imperiled.

Environmental Vacations: Volunteer Projects to Save the Planet, by Stephanie Ocko, 2nd edition, John Muir Publications, 1992. Distributed by W.W. Norton & Co., 248 pages. This book describes ways in which nonscientists can assist experts in activities (such as monitoring the diversity of rainforests), observing animal behavior or other projects, giving particulars on the projects and how to become involved.

The Globe program for classrooms involves students from around the world who participate in ecology studies by gathering and analyzing data; ncdc.noaa.gov/GLOBE/globe.html. It is affiliated with the National Oceanic and Atmospheric Administration (NOAA).

Green Teacher, P.O. Box 1431, Lewiston, NY 14092; or in Canada, 95 Robert St., Toronto, Ontario M5S 2K5, Canada. Five issues per year, $27.00; sold on newsstands also. This magazine is very well done. It lists environmental projects and activities and has a humane orientation. Some articles are in both French and English.

Knowledge Unlimited, P.O. Box 52, Madison, WI 53701-0052; www.ku.com. This catalog lists videos, filmstrips, resource guides, classroom posters, books and other educational materials under major categories, including Science, which has many listings on endangered species and environmental topics.

National Geographic Society. The Educational Services department of the National Geographic Society provides material, films and filmstrips on general science and biology, including endangered species and habitats. Its free catalog, fiSchool Publishing,fl for Grades K-12 offers a wide variety of environmental books, videos, CD-ROMs and other visual material accompanied by teachers™ guides. An Internet site designed for teachers gives further detail: www.nationalgeographic.com/education. One learning packet centers on the Tiger. The teaching guide includes lessons on habitat, populations, adaptation, predator/prey relationships, conservation and scientific studies, accompanied by two videos the society produced on the species, slides, posters and student handouts. Another teaching unit describes The Jason Project Expeditions, sponsored in part by the National Geographic Society. Each centers on a part of the world. These kits combine studies of a variety of disciplines centered on an area or country: biology, climate study, geology and others.

Students learn how to measure pollutants and study endangered species™ diets. These lessons are also shown on the new National Geographic television channel. An interactive encyclopedia CD-ROM on Mammals, for Grades 2-12, allows students to see and hear more than 200 mammals through photos, range maps, acoustics, facts on endangered species, mystery games that test powers of deduction, and a lesson plan booklet. Videos made for the classroom on many subjects include a series on bioscience, showing life cycles of various insects, a trout river ecosystem, and other themes for various grade levels. Each includes a teacher™s guide and is described in the Teacher Store page or in the Video and Media Catalog. Anatomy of frogs and other animals are included in material that teaches function, taxonomy and structure. For the growing number of teachers and students who would rather find another means of learning about frog or mammal anatomy rather than dissection, especially in view of the declining status of frogs, this material provides a solution. (Also see the Projects Section in this book, fiLearning Animal Anatomy Without Dissection.fl)

*Rainforest Teacher™s Packet.*Rainforest Action Network, 221 Pine St., Suite 500, San Francisco, CA 94104. Educational materials listed on www.ran.org; Phone: 415-398-4404. Students and others may sign up for fiaction alertsfl on issues affecting the world™s rainforests.

The Rainforest Book. How you can save the world™s rainforests, by Scott Lewis with the Natural Resources Defense Council, Living Planet Press, 1990. Aimed toward students, the text has chapters on the importance of rainforests, both tropical and US temperate rainforests, how they can be saved and how individuals can help with specific examples of aiding organizations, encouraging local businesses not to buy rainforest products, visiting rainforests, adopting an acre of rainforest, and further reading, films and other information sources.

Save America™s Forest. Citizen Action Guide The activist organization, Save America™s Forests, has published a 51-page how-to guide for citizens and/or students to work within communities to educate others on the decline of America™s forests from clearcutting and over-harvesting. It is available online at www.saveamericasforestsfund.org. Also available from this organization, a slide show, fiClearcuts Coast to Coastfl (purchase or rental); an annotated bibliography on forests; and the award-winning video, fiThe Last Ancient Forestsfl (11 minutes, purchase $7). Save America™s Forests, 4 Library Ct., SE, Washington, DC 20003; www.saveamericasforests.org; Phone: 202-544-9219.

Science Teacher. National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201-3000; Phone: 703-243-7100; www.nsta.org. Published nine times a year, this is a valuable periodical, aiding teachers of environmental subjects.

Teacher™s Guide to World Resources and Biodiversity(ISBN 0-7872-4259-4), 2001. This guide provides economic, ecological, ethical and esthetic reasons why we should care that species are becoming extinct. Students explore the root causes of biodiversity loss and strategies for conservation. Cost is $9.99. Published and distributed by Kendall Hunt, it can be ordered online through their Web site. The site also includes fiEndangered Forestsfl and many other titles on the environment. Discounts are given to teachers who order in bulk. Web site: www.kendallhunt.com; Phone: 1-800-542-6657.

fiUnderstanding Biodiversity.fl Encyclopedia Britannica™s 19-minute video is aimed at high school students. It stresses the need for ecosystems to have diverse life forms and the important roles different types of scientists play in biodiversity preservation. The cloud forests of Venezuela are the background for teaching this subject. A Teacher™s Guide is included, listing objectives and suggestions for classroom discussion topics. Encyclopedia Britannica Educational Corporation (1-800-554-9862).

fiBritannica. Electronic Media Catalogfl descries many videos (without teachers™ guides) on the environment and wildlife. It also offers a fiGuide to Dissection,fl in which a video software package with four parts shows dissections of a rat, frog, pigeon and dogfish. Using software, the student can do a virtual dissection with a computer mouse.

Video Project. Free catalog of educational environmental videos for use in schools and libraries. Video Project, P.O. Box 77188, San Francisco, CA 94107; Phone: 1-800-4-PLANET; www.videoproject.net.

The Wild Ones. The Wildlife Trust (formerly the Wildlife Preservation Trust) is a sister organization to the Durrell Conservation Trust in the United States, founded by Gerald Durrell, noted author and conservationist, which works on environmental and endangered species programs throughout the world. For students, the organization sponsors fiThe Wild Onesfl (www.thewildones.org), which includes a newsletter, *The Wild Ones*, and accompanying fiTeacher Connection,fl both of which can be downloaded from its Web site. The latter enrolls classes and provides suggestions for curriculum activities involving conservation, endangered species, natural history and related topics that complement the newsletter. *The Wild Ones* is also published in other countries, such as Mexico, translated into Spanish, with added topics pertaining to that country™s environment and wildlife.

Letters and artwork from students around the world are published on the site. Through the Web site, students can write the scientists working on various projects for the organization. The newsletter for the general membership, *On the Edge*, often focuses on particular endangered species; recent issues may be accessed through the Web site under fiField Notes,fl with the year of publication. The organization in the United Kingdom, which publishes the newsletter *The Dodo Dispatch* (ages 7-16), and the Canadian sister organization can be reached through the Web site as well. The Wildlife Trust, 61 Route 9W, Palisades, NY 10964-8000; Phone: 845-365-8337; www.wildlifetrust.org.

Wildlife Review Abstracts, National Information Services Corporation, 3100 St. Paul St., Suite 806, Baltimore, MD 21218. Formerly a quarterly report published by the US Fish and Wildlife Service, these annotated bibliographies are now a privately run database system with 514,000 entries of publications on wildlife and the environment, indexed by species, subject and geographical areas. Abstracts from wildlife, fisheries, ornithological, ecological and forestry journals are sold through a yearly subscription for $1,045. The data is available on CD-ROM and is compiled from many sources. The Wildlife Species Information Library at the site includes data on habitats in states from a

DOS-based CD-ROM or 45,000 pages of online species™ profiles. Phone: 410-243-0797; www.nisc.com.

Internet
All Endangered Species:
IUCN Red List of Threatened Species: www.redlist.org/
FWS Endangered Species Program: www.fws.gov/endangered/
WWF Wildfinder: www.worldwildlife.org/wildfinder/

Bats:
Bat Conservation International: www.batcon.org
www.bahnhof.se/~pettersson (identifying bats by their sound waves)
Swedish Bat Detector company: www.batsound.com.

Bears:
Nature Net: www.naturenet.com/bears/.
Discovering Lewis & Clark: www.lewis-clark.org.
Yellowstone National Park: www.yellowstone-natl-park.com/bearstor.htm.
Great Bear Foundation: www.greatbear.org.

Birds:
The Peregrine Fund: www.peregrinefund.org
(California Condor and other reintroduced endangered birds of prey).
Warbler Watch of Cornell Laboratory of Ornithology and National Audubon Society: birdsource.cornell.edu.
US Fish and Wildlife Service, endangered species breeding center at Patuxent Wildlife Research Center: mbr-pwrc.usgs.gov/bbs/ident.html.
Peterson Multimedia Guides: (sightings of rare birds): www.petersononline.com.
The Raptor Center, University of Minnesota (tracks Ospreys in their winter migration): www.raptor.cvm.umn.edu.

Butterflies:
Bugbios: insects.org/ced4/symbol_list3.html.
Journey North: learner.org/jnorth/current.html (tracing Monarch Butterfly migrations to Mexico, with classroom participation in the United States and Mexico).
Cornell Center for the Environment: www.cfe.cornell.edu (projects to monitor butterfly populations).
A World for Butterflies: www.aworldforbutterflies.com (Dr. Philip Shappert, editor of *News of the Lepidopterists™ Society* and author of *A World for Butterflies*).

Marine Species:
Sea Turtle Survival League: www.cccturtle.org (sea turtle tracking with satellite transmitters).
The Karen Beasley Sea Turtle Rescue and Rehabilitation Center: www.seaturtlehospital.org (hospital for injured and sick sea turtles, many with shattered shells from boat collisions and infections from pollution during nesting season, volunteers protect 100 nests and hatchlings).
University of Maine™s Lobster Institute: www.lobster.um.maine.edu/lobster
(live video of lobsters in the wild).
SeaWeb: www.seaweb.org (marine education).
Ocean Planet, The Smithsonian Institution: seawifs.gsfc.nasa.gov/oceanplanet.html

(traveling exhibits with links to background material).
Woods Hole Oceanographic Institution: www.whoi.edu
(research projects and access to its library and oceanographic sites).
Mote Marine Laboratory: www.marinelab.sarasota.fl.us
(information about red tides and sea turtle rehabilitation).
SeaWatch: www.seawatch.org or www.seawatchfoundation.org.uk.

Wolves and Wild Dogs:
NOVA/PBS: www.pbs.org/wgbh/nova/wolves.
Penn State College of Earth and Mineral Sciences: www.ems.psu.edu.
Yellowstone Wolf Report: yellowstone-natl-park.com/wolf.html.
Wolf Haven International: www.wolfhaven.org.
Wolf Education and Research Center: www.wolfcenter.org.
Defenders of Wildlife wolf program: www.defenders.org.

Timber Wolf Information Network: www.timberwolfinformation.org.
Wild Canid Survival and Research Center: www.wolfsanctuary.org.
The Association for Nature fiWolffl: www.most.org.pl/wolf
(Godziszka, Poland; wolves in Poland and Europe).
International Wolf Center: www.wolf.org.
Dhole home page: www.cuon.net/dholes (information on the Asiatic wild dog, its biology, research and conservation).

Organizations

A Œ B Œ C Œ D Œ E Œ F Œ G Œ H Œ I Œ J - K - L - M

N Œ O Œ P Œ Q Œ R Œ S Œ T Œ U Œ V Œ W Œ X Œ Y - Z

Organizations: A

African Wildlife Foundation, 1400 - 16th St., NW, Suite 120, Washington, DC 20036; Phone: 202-939-3333; http://www.awf.org/. Quarterly magazine, *African Wildlife News*.

Alaska Wildlife Alliance, P.O. Box 202022, Anchorage, AK 99520-2022; Phone: 907-277-0897; http://www.akwildlife.org/.

Alliance for the Wild Rockies, P.O. Box 8731, Missoula, MT 59807; Phone: 406-721-5420; http://www.wildrockiesalliance.org/.

Amazon Conservation Team, 4211 N. Fairfax Dr., Arlington, VA 22203; Phone: 703-522-4684; http://www.ethnobotany.org/.

American Anti-Vivisection Society, 801 Old York Rd., #204, Jenkintown, PA 19046-1685; Phone: 215-887-0816; http://www.aavs.org/.

American Association of Botanical Gardens and Arboreta, 351 Longwood Road, Kennett Square, PA 19348; Phone: 610-925-2500; http://www.aabga.org/.

American Association of Wildlife Veterinarians: http://www.aawv.net/.

American Bird Conservancy, P.O. Box 249, The Plains, VA 20198; Phone: 540-253-5780; http://www.abcbirds.org/

American Birding Association, P.O. Box 6599, Colorado Springs, CO 80934; Phone: 719-578-1480; http://www.americanbirding.org/.

American Cetacean Society, P.O. Box 1391, San Pedro, CA 90733-0391; Phone: 310-548-6279; http://www.acsonline.org/.

American Chestnut Foundation, 469 Main St., P.O. Box 4044, Bennington, VT, 05201-4044; Phone: 802-447-0110; http://chestnut.acf.org/.

American Fisheries Society, 5410 Grosvenor Ln., Bethesda, MD 20814; Phone: 301-897-8616; http://www.fisheries.org/.

American Forests, P.O. Box 2000, Washington, DC 20013; Phone: 202-955-4500; http://www.amfor.org/.

American Fund for Alternatives to Animal Research, 175 West 79th St., Suite 16-G, New York, NY 10011; Phone: 212-989-8073; http://www.uiowa.edu/~vpr/research/animalt.htm.

American Museum of Natural History, Central Park West at 79th St., New York, NY 10024-5192; Phone: 212-769-5606; http://www.amnh.org/. *Natural History*, 10 issues/year.

American Oceans Campaign, 600 Pennsylvania Ave., SE, Suite 210, Washington, DC 20003; Phone: 202-544-3526; http://www.americanoceans.org/.

American Ornithologists™ Union, Museum of Natural History, 10th and Constitution, NW, #116, Washington, DC 20560; Phone: 202-357-2051; http://www.aou.org/.

American Rivers, 1025 Vermont Ave., NW, Suite 720, Washington, DC 20005; Phone: 202-347-7550; http://www.americanrivers.org/.

American Society for the Prevention of Cruelty to Animals (ASPCA), 424 East 92nd St., New York, NY 10128; Phone: 212-876-7700; http://www.aspca.org/. Quarterly magazine, *ASPCA Animal Watch*.

American Society of Mammalogists: http://www.mammalsociety.org/.

American Veterinary Medical Association, 1931 N. Meacham Rd., Suite 100, Schaumburg, IL 60173; Phone: 847-925-8070; http://www.avma.org/.

American Zoo and Aquarium Association, Oglesbay Park, Wheeling, WV 26003; Phone: 304-242-2160; http://www.aza.org/.

Amigos del Bosque, Mr. Noe Adalberto Ventura Loyo, 9a Calle 2-23 zona 1, 01001 Guatemala City, Guatemala; Phone: 502-2-21-14-40. Rainforest protection organization.

Ancient Forests International, P.O. Box 1850, Redway, CA 95560; Phone: 707-923-4475; http://www.ancientforests.org/. *News of Old Growth* newsletter.

Animal Legal Defense Fund, 127 Fourth St., Petaluma, CA 94952; Phone: 707-769-7771; http://www.aldf.org/.

Animal Protection Institute, P.O. Box 22505, Sacramento, CA 95822; Phone: 916-447-3085; http://www.api4animals.org/.

Animal Welfare Information Center, US Department of Agriculture, Agricultural Research Service, National Agricultural Library, 10301 Baltimore Ave., 4th Fl., Beltsville, MD 20705-2351; Phone: 301-504-6212; http://www.nal.usda.gov/awic.

Animal Welfare Institute, 900 Pennsylvania Avenue, SE, Washington DC 20003; Phone: 202-337-2332; http://www.awionline.org/. *AWI Quarterly* newsletter; reports and educational materials.

Animals™ Agenda, The, P.O. Box 25881, Baltimore, MD 21224; Phone: 410-675-4566; http://www.animalsagenda.org/.

Ark Trust, Inc., P.O. Box 8191, Universal City, CA 91618-8191; Phone: 818-501-2ARK; http://www.arktrust.org/. Presents Genesis Awards to members of media for films and television programs that promote animal conservation and humane treatment.

Association for Nature fiWolf,fl ul. Gorska 69, 43-376 Godziska, Poland; http://www.most.org.pl/wolf.

Association of Veterinarians for Animal Rights, P.O. Box 208, Davis, CA 95617-0208; Phone: 530-759-8116; http://www.avar.org/.

Atlantic Salmon Federation, International Headquarters, P.O. Box 5200, St. Andrews, New Brunswick E5B 3S8, Canada; Phone: 506-529-1033.

Audubon Naturalist Society, 8940 Jones Mill Rd., Chevy Chase, MD 20815; Phone: 301-652-9188.

Australian Rainforest Conservation Society, 19 Colorado Ave., Bardon Queensland 4065, Australia; Phone: 61-7-3368-1318; http://www.rainforest.org.au/.

Australasian Bat Society: batcall.csu.edu.au/batcall/abs.

Organizations: B

Bat Conservation International, P.O. Box 162603, Austin, TX 78716; Phone: 512-327-9721; http://www.batcon.org/.

Bat Conservation Trust, The, 15 Cloisters House, 8 Battersea Park Rd., London SW8 4BG, England; Phone: 020-7627-2629; http://www.bats.org.uk/.

Beyond Pesticides, 701 E St., SE, #200, Washington, DC 20003; Phone: 202-543-5450; http://www.beyondpesticides.org/.

Biodiversity Resource Center. See California Academy of Sciences. *Pesticides and You* newsletter.

Biogems, project of the Natural Resources Defense Council, 40 West 20th St., New York, NY 10011; Phone: 212-727-2700; http://www.savebiogems.org/.

BirdLife International (formerly the International Council for Bird Preservation),Wellbrook Court, Girton Rd., Cambridge CB3 ONA, United Kingdom; Phone: +44-1-223-277-318. *World Birdwatch*, quarterly newsletter; http://www.birdlife.net/.

Bluewater Network (a project of Earth Island Institute re: ocean conservation and water pollution), 311 California, Suite 510, San Francisco, CA 94104; bluewaternetwork.org.

Bushmeat Crisis Task Force: http://www.bushmeat.org/. Coalition of organizations working to control slaughter of wildlife, especially endangered species such as Chimpanzees, for sale in markets.

Organizations: C

California Academy of Sciences, 55 Concourse Dr., Golden Gate Park, San Francisco, CA 94118-4599; www.calacademy.org/research/library/biodiv/ lists extensive bibliography of regions and species. *California Wild* (formerly *Pacific Discovery*), quarterly magazine published by the Academy by subscription or on newsstands.

Canadian Nature Federation, 1 Nicholas St., Ottawa, Ontario K1N 7B7, Canada; Phone: 1-800-267-4088; http://www.cnf.ca/.

Center for Biological Diversity, P.O. Box 710, Tucson, AZ 85702-0710; Phone: 520-623-5252; http://www.biologicaldiversity.org/.

Center for Captive Chimpanzee Care, P.O. Box 12220, Fort Pierce, FL 34979; Phone: 561-429-0403;

http://www.savethechimps.org/.

Center for Coastal Studies, P.O. Box 1036, Provincetown, MA 02657; Phone: 508-487-6115; http://www.coastalstudies.org/. Conducts whale and other marine mammal rescues and research.

Center for Marine Conservation: See The Ocean Conservancy.

Conservation, P.O. Box 299, St. Louis, MO 63166-0299; Phone: 314-577-9450; http://www.mobot.org/cpc.

Center for Safe Energy, Earth Island Institute, 2828 Cherry St., Berkeley, CA 94705; Phone: 510-883-1177; http://www.earthisland.org/cse.

Center for Science in the Public Interest, 1875 Connecticut Ave., NW, Suite 300, Washington, DC 20009; Phone: 202-332-9110; http://www.cspinet.org/.

Center for the Study of Tropical Birds, 218 Conway Dr., San Antonio, TX 78209-1716; Phone: 1-800-858-CSTB; http://www.cstbinc.org/.

Center for Whale Research, 1359 Smugglers Cove, P.O. Box 1577, Friday Harbor, WA 98250-0157; Phone: 360-378-5835; http://www.whaleresearch.com/.

Cetacean Society International, P.O. Box 953, Georgetown, CT 06829; Phone: 203-431-1606; http://www.csiwhalesalive.org/.

Chesapeake Bay Foundation, The, Philip Merrill Environmental Center, 6 Herndon Ave., Annapolis, MD 21403; Phone: 1-888-SAVE-BAY; http://www.savethebay.cbf.org/.

Chihuahuan Desert Research Institute, P.O. Box 905, Ft. Davis, TX 79734; Phone: 915-364-2499; http://www.cdri.org/.

Chimp Haven, Inc., 710 Spring St., Shreveport, LA 71101; Phone: 1-888-98CHIMP; http://www.chimphaven.org/.

Clean Water Action, 4455 Connecticut Ave., NW, Suite A-300, Washington, DC 20003-2328; Phone: 202-895-0420; http://www.cleanwateraction.org/.

Clean Water Network, 1200 New York Ave., NW, Washington, DC 20003; Phone: 202-289-2395; http://www.cwn.org/.

College and University home pages: http://www.utexas.edu/world/univ.

Conservation Foundation (part of World Wildlife Fund), 1250 - 24th St., NW, P.O. Box 97180, Washington, DC 20090-7180; Phone: 202-293-4800; http://www.worldwildlife.org/. United Kingdom: Panda House, Weyside Park, Godalming, Surrey GU7 1XR, United Kingdom; Phone: 01483 426444; http://www.wwf-uk.org/.

Conservation International, 1919 M St., Suite 600, Washington, DC 20036; Phone: 1-800-406-2306; http://www.conservation.org/.

Cornell Lab of Ornithology, 159 Sapsucker Woods Rd., Ithaca, NY 14850-1998; Phone: 1-800-843-BIRD; http://www.birds.cornell.edu/. *Living Bird* journal.

Cousteau Society, The, 870 Greenbrier Cir., Suite 402, Chesapeake, VA 23320-2641;

http://www.cousteausociety.org/; Phone: 1-800-441-4395.

Cultural Survival, 215 Prospect St., E., Cambridge, MA 02138; Phone: 617-441-5417; http://www.culturalsurvival.org/.

Organizations: D

Defenders of Wildlife, 1101 - 14th St., NW, Suite 1400, Washington, DC 20005; Phone: 202-682-9400; http://www.defenders.org/. *Defenders*, bimonthly-monthly magazine.

Defensores de la Naturaleza, 19 Avenida fiBfl 0-83, Zona 15, Vista Hermosa II, Guatemala 01015; Phone: 502-369-5167; eco-web.com/register/02222.html.

Desert Tortoise Preservation Committee, 4067 Mission Inn Ave., Riverside CA 92501; Phone: 909-683-3872; http://www.tortoise-tracks.org/.

Dian Fossey Gorilla Fund International, The, 800 Cherokee Ave., SE, Atlanta, GA 30315-1440; Phone: 1-800-851-0203; http://www.gorillafund.org/.

Dolphin Project, The, P.O. Box 224, Coconut Grove, FL 33233; Phone: 305-668-1619. Founder, Richard O™Barry, works to stop capture of wild dolphins and to rehabilitate and release captive dolphins.

Durrell Wildlife Conservation Trust (formerly the Jersey Wildlife Preservation Trust), Les Augres Manor, Trinity, Jersey, Channel Islands JE3 5BP, British Isles; Phone: +44(0)1534 860000; http://www.durrellwildlife.org/. *The Dodo*, annual journal; *The Dodo Dispatch* for young people.

Organizations: E

E. The Environmental Magazine, P.O. Box 2047, Marion, OH 43305-2047; Phone: 815-734-1242; http://www.emagazine.com/. Bimonthly magazine published by Earth Action Network, Inc., Norwalk, CT 06851.

Eagle Nature Foundation, The, 300 E. Hickory St., Apple River, IL 61001; Phone: 815-594-2305; http://www.eaglenature.net/.

Earth First!, P.O. Box 3023, Tucson, AZ 85702; Phone: 520-620-6900; http://www.earthfirstjournal.org/. *Earth First!* newsletter.

Earth Island Institute, 300 Broadway, Suite 28, San Francisco, CA 94133; Phone: 415-788-3666; http://www.earthisland.org/. *Earth Island Journal*, quarterly magazine.

Earthjustice Legal Defense Fund (formerly Sierra Club Legal Defense Fund), 426 - 17th St., 6th Fl., Oakland, CA 94612-2820; Phone: 510-550-6700; http://www.earthjustice.org/. *In Brief*, newsletter

Earthwatch Australia, 126 Bank St., South Melbourne, Victoria 3305, Australia; Phone: 61-3-9682-6828; earthwatch.org/australia/au.html.

Earthwatch Institute, 3 Clock Tower Pl., Suite 100, P.O. Box 75, Maynard, MA 01754-9928; Phone: 1-800-776-0188; http://www.earthwatch.org/.

Eco Travel Center: www.ecotour.org.

Ecological Society of America, 1707 H St., NW, Suite 400, Washington, DC 20006; Phone: 202-833-8773; http://www.esa.org/.

Ecology Fund, 216 E. Huron, Ann Arbor, MI 48104; Phone: 734-213-7777; http://www.ecologyfund.com/. Save open space by clicking on to your choice of threatened animals; e.g., parrot habitat in Mexico, bear habitat in Canada, or around the world.

Ecotourism Society, The, P.O. Box 668, Burlington, VT 05402; Phone: 802-651-9818; http://www.ecotourism.org/.

Elm Research Institute, Elm St., P.O. Box 150, Westmoreland, NH 03467; Phone: 1-800-FOR-ELMS; http://www.forelms.org/. Members receive press releases and can apply for free elm trees; information on projects and saving diseased elms.

Endangered Species Project, 1836 - 14th St., NW, Washington, DC 20009; Fort Mason Center, E-205, San Francisco, CA 94123; Phone: 415-921-3140.

Environmental Action, 6930 Carroll Ave., Suite 600, Takoma Park, MD 20912; Phone: 301-891-1100.

Environmental Defense (formerly Environmental Defense Fund), 257 Park Ave., S., New York, NY 10010; Phone: 212-505-2100; http://www.environmentaldefense.org/.

Environmental Education Associates, P.O. Box 1802, San Anselmo, CA 94979; Phone: 415-281-3388. Integrates environmental material into regular curriculum at school.

Environmental Law Institute, 1616 P St., NW, Suite 200, Washington, DC 20036; Phone: 202-939-3800; http://www.eli.org/.

Environmental Media Services, 1320 - 18th St., NW, 2nd Fl., Washington, DC 20036; Phone: 202-463-6670; http://www.ems.org/.

Environmental News Network, 2020 Milvia, Suite 411, Berkeley, CA 94704; http://www.enn.com/index.asp. Lists sites offering free donations to environmental organizations.

Environmental Resource Center, P.O. Box 819, Ketchum, ID 83340; Phone: 208-726-4337.

Environmental Working Group, 1718 Connecticut Ave., NW, Suite 600, Washington, DC 20009; Phone: 202-667-6982; http://www.ewg.org/.

Organizations: F

Fauna and Flora International, Great Eastern House, Tenison Rd., Cambridge CB1 2TT, United Kingdom; Phone: 44 1223 57 1000; http://www.fauna-flora.org/. *Oryx, The International Journal of Conservation*.

Forests Forever, 973 Market St., Suite 450, San Francisco, CA 94103; Phone: 415-974-3636; http://www.forestsforever.org/.

Forest Service Employees for Environmental Ethics (FSEEE), P.O. Box 11615, Eugene, OR 97440; Phone: 541-484-2692; http://www.fseee.org/.

Forest Stewardship Council, 1155 - 30th St., NW, Suite 300, Washington, DC 20007; Phone: 202-342-6589; http://www.fscus.org/.

Fossil Rim Wildlife Center, P.O. Box 2189, Glen Rose, TX 76043; Phone: 254-897-2960; http://www.fossilrim.org/. Breeds endangered wildlife.

Friends of Animals, 777 Post Rd., Suite 205, Darien, CT 06820; Phone: 203-656-1522; http://www.friendsofanimals.org/. *Action Line*, quarterly magazine.

Friends of the Earth, 1021 Vermont Ave., NW, Washington, DC 20005; Phone: 202-783-7400; http://www.foe.org/.

Friends of the Everglades, 7800 Red Rd., Suite 215-K, Miami, FL 33143; Phone: 305-669-0858; http://www.everglades.org/.

Friends of the Sea Otter, 125 Ocean View Blvd., #204, Pacific Grove, CA 93950; Phone: 831-373-2747; http://www.seaotters.org/. *Sea Otter Raft*, newsletter.

Fund for Animals, 200 West 57th St., New York, NY 10019; Phone: 212-246-2096; http://www.fund.org/.

Fundacao Botanica Margaret Mee, Av. General Justo 171/8e Andar, CEP 2222-1-090, Centro, Rio de Janeiro, RJ Brazil; Phone: 55-21-533-1486.

Fundacao Vitoria Amazonica, Rua R/S Quadra Q, Casa 7, Conjunto Morado do Sol, Manaus, Amazonas 69060-080, Brazil; Phone: 55-92-642-1336.

Organizations: G

Gaia Foundation, C/O Redbridge Community Development Agency, South Ilford Community Centre, Eton Rd., Ilford, Essex 1G1 2UE, United Kingdom; Phone: 44-20-8554-9389; http://www.foundation-gaia.org/.

Global Rivers Environmental Education Network, C/O Earth Force, 1908 Mount Vernon, 2nd Fl., Alexandria, VA 22301; Phone: 703-299-9400; http://www.earthforce.org/green/

Gopher Tortoise Council, C/O Florida Museum of Natural History, University of Florida, P.O. Box 17800, Gainesville, FL 32611; http://www.gophertortoisecouncil.org/. *Tortoise Burrow* and *The Bulletin*, newsletters.

Gorilla Foundation, The, P.O. Box 620530, Woodside, CA 94062; Phone: 1-800-634-6273; http://www.koko.org/. *Gorilla*, quarterly journal.

Great Ape Project International, The, P.O. Box 19492, Portland, OR 97280-0492; http://www.greatapeproject.org/.

Great Bear Foundation, P.O. Box 9383, Missoula, MT 59807; Phone: 406-829-9378; http://www.greatbear.org/. *Bear*

News, quarterly newsletter.

Greater Yellowstone Coalition, P.O. Box 1874, 13 S. Wilson, Suite 2, Bozeman, MT 59771; Phone: 406-586-1593; http://www.greateryellowstone.org/.

Greenpeace International, Keizersgracht 176, 1016 DW Amsterdam, The Netherlands; Phone: 31 20 523 6222; http://www.greenpeace.org/.

Greenpeace USA, 702 H St., NW, Suite 300, Washington, DC 20001; Phone: 1-800-326-0959; http://www.greenpeaceusa.org/.

The Greens. Green Party USA, P.O. Box 30208, Kansas City, MO 64112; Phone: 816-931-9366; http://www.greenparty.org/. Grassroots political party committed to ecological values and respect for nature and wildlife.

Organizations: H - I

Humane Society of the United States, 2100 L St., NW, Washington, DC 20037; Phone: 202-452-1100; http://www.hsus.org/. *Humane Society News*, quarterly magazine; *Allanimals*, quarterly magazine.

International Bee Research Association, 18 North Rd., Cardiff, CF10 3DT, United Kingdom; Phone: +44 (0) 2920 372409; http://www.cfac.uk/ibra.

International Bird Rescue Research Center, 4369 Cordelia Rd., Suisun, CA 94585; http://www.ibrrc.org/; Phone: 707-207-0380.

International Crane Foundation, P.O. Box 447, Baraboo, WI 53911; Phone: 608-356-9462; http://www.savingcranes.org/. *ICF Bugle*, newsletter.

International Fund for Animal Welfare, P.O. Box 193, Yarmouth Port, MA 02675; Phone: 508-744-2000 or 1-800-932-IFAW; http://www.ifaw.org/.

International Rivers Network, 1847 Berkeley Way, Berkeley, CA 94703; Phone: 510-848-1155; http://www.irn.org/.

International Snow Leopard Trust, 4649 Sunnyside Ave., N., Suite 325, Seattle, WA 98103; Phone 206-632-2421; http://www.snowleopard.org/.

IUCN (International Union for the Conservation of Nature and Natural Resources), Rue Mauverney 28, CH-1196 Gland, Switzerland; www.iucn.org. Publications Unit: 219c Huntingdon Rd., Cambridge CB4 5PP, United Kingdom; Phone: 44-1223-277894. *Red Lists of Threatened Animals*: http://www.redlist.org/. IUCN publications catalog available at Publications Unit address. Some publications available in the United States from Island Press (1-800-828-1302).

International Wildlife Coalition, 70 E. Falmouth Hwy., East Falmouth, MA 02536; Phone: 508-548-8328; http://www.iwc.org/.

International Wolf Center, 1396 Hwy. 169, Ely, MN 55731-8129; Phone: 218-365-4695; http://www.wolf.org/.

Organizations: J - K - L
Jane Goodall Institute, The, P.O. Box 14890, Silver Spring, MD 20910-4890; Phone: 301-565-0086; http://www.janegoodall.org/. Primate protection and environmental education, with emphasis on chimpanzees.

Jersey Wildlife Preservation Trust: See Durrell Conservation Trust (United Kingdom) and Wildlife Trust (US).

League of Conservation Voters, 1920 L St., NW, Suite 800, Washington, DC 20016; Phone: 202-785-8683; http://www.lcv.org/.

Loon Preservation Committee, P.O. Box 604, Moultonborough, NH 03254; Phone: 603-476-5666; http://www.loon.org/.

Organizations: M
Marine Education Center of Cape Ann, P.O. Box 3015, Gloucester, MA 01930; Phone: 415-289-7325; http://www.cape-ann.com/. Rescues and rehabilitates injured and stranded marine mammals.

Marine Mammal Center, The, Marin Headlands, 1065 Fort Cronkhite, Sausalito, CA 94965; Phone: 415-289-7325; http://www.tmmc.org/. Rescues and rehabilitates injured and stranded marine mammals.

Massachusetts Audubon Society, 208 South Great Rd., Lincoln, MA 01773; Phone: 781-259-9661; http://www.massaudubon.org/. *Sanctuary*, bimonthly magazine.

Missouri Botanical Garden, St. Louis, MO 63101; Phone: 314-577-5100; http://www.mobot.org/. Information on endangered plants, including tropical forest species.

Mountain Gorilla Conservation Fund, P.O. Box 2211, Englewood, CO 80150-2211; Phone: 303-781-3484; http://www.mountaingorillaconservationfund.org/ and http://www.gorilla100.com/.

Museums in the United States: http://www.museumca.org/usa.

Organizations: N
National Audubon Society, 700 Broadway, New York, NY 10003; Phone: 212-979-3000; http://www.audubon.org/. *Audubon*, bimonthly magazine available by subscription and on newsstands.

National Coalition for Marine Conservation, 3 N. King St., Leesburg, VA 20176; Phone: 703-777-0037; http://www.savethefish.org/.

National Foundation to Protect America™s Eagles, Save the Eagle Project, P.O. Box 120206, Nashville, TN 37212; Phone: 615-847-4171.

National Geographic Society, 1145 - 17th St., NW, Washington, DC 20036; Phone: 202-857-7000; http://www.nationalgeographic.com/. *National Geographic*, monthly publication available by subscription and on newsstands. *World Magazine*, publication for young people, includes articles on endangered species and habitat.

National Parks and Conservation Association, 1300 - 19th St., NW, Suite 300, Washington, DC 20036; Phone: 1-800-628-7275; http://www.npca.org/. *National Parks* magazine for members.

National Wildflower Research Center, Lady Bird Johnson Wildflower Center, 4801 LaCrosse Ave., P.O. Box 149187, Austin, TX 78739; Phone: 512-292-4200; http://www.wildflower.org/. *Wildflower*, bimonthly newsletter for members.

National Wildlife Rehabilitators Association, 14 N. Seventh Ave., St. Cloud, MN 56303-4766; Phone: 320-259-4-86; http://www.nwrawildlife.org/.

Native Forest Council, P.O. Box 2190, Eugene, OR 97402; Phone: 541-688-2600; http://www.forestcouncil.org/.

Native Seeds/SEARCH, 526 N. Fourth Ave., Tucson, AZ 85706; Phone: 520-622-5561; http://www.nativeseeds.org/. Distributes seeds of indigenous North American plants. *The Seedhead News*.

Natural Resources Defense Council, 40 West 20th St., New York, NY 10011; Phone: 212-727-2700; http://www.nrdc.org/.

Nature Conservancy, The, 4245 N. Fairfax Dr., Suite 100, Arlington, VA 22203-1606; Phone: 1-800-628-6860; nature.org. *Nature Conservancy*.

Negative Population Growth, 1717 Massachusetts Ave., NW, Suite 101, Washington, DC 20036; Phone: 202-667-8950; http://www.npg.org/.

New England Aquarium, Central Wharf, Boston, MA 02110; Phone: 617-973-5200; http://www.neaq.org/. Programs include rescue of marine mammals and sea turtles and rehabilitation for release.

New England Wild Flower Society, 180 Hemenway Rd., Framingham, MA 01701-2699; http://www.newfs.org/; Phone: 508-877-7630. *New England Wild Flowers*, magazine published three times a year. Web site includes *Directory of Native Plant Societies*.

New York Times Science Times: http://www.nytimes.com/.

North American Bluebird Society, The Wilderness Center, P.O. Box 244, Wilmot, OH 44689-5511; http://www.nabluebirdsociety.org/; Phone: 330-359-5511. *Bluebird*, newsletter.

North American Butterfly Association, 4 Delaware Rd., Morristown, NJ 07960; www.naba.org. *American Butterflies* and *Butterfly Gardener*.

North American Loon Fund, P.O. Box 68, Mt. Pleasant, MI 44804; facstaff.uww.edu/wentzl/nalf/analfhomepage.html; Phone: 989-772-9611.

North American Native Fishes Association, 1107 Argonne Dr., Baltimore, MD 21218; http://www.nanfa.org/.

Organizations: O

Ocean Conservancy, The (formerly Center for Marine Conservation), 1725 DeSales St., NW, Suite 500, Washington, DC 20036; http://www.oceanconservancy.org/; Phone: 202-429-5609. *The Blue Planet*, quarterly magazine.

Ocean Realm (quarterly magazine), 4067 Broadway, San Antonio, TX 78209; http://www.oceanrealm.net/; Phone: 210-824-8099.

Oil Spill Intelligence Report: http://www.cutter.com/.

Orangutan Foundation International, 822 S. Wellesley Ave., Los Angeles, CA 90049; http://www.orangutan.org/; Phone: 1-800-ORANGUTAN. Founder, Birute Galdikas, directs rescue and rehabilitation of orphaned and confiscated orangutans on Borneo and conducts scientific research on the species™ ecology and conservation.

Orion Society, 187 Main St., Great Barrington, MA 01230; oriononline.org; Phone: 1-800-909-6568 or 413-528-4422. *Orion. People and Nature* quarterly magazine.

Organizations: P

People for the Ethical Treatment of Animals (PETA), 501 Front St., Norfolk, VA 23510; http://www.peta.org/; Phone: 757-622-7382. *PETA™s Animal Times*, quarterly magazine.

Peregrine Fund, The, 5666 W. Flying Hawk Ln., Boise, ID 83709; http://www.peregrinefund.org/; Phone: 208-362-3716.

Performing Animal Welfare Society (PAWS), P.O. Box 849, Galt, CA 95632; http://www.pawsweb.org/; Phone: 866-FOUR-PAWS; 209-745-2606. Fights cruelty against elephants and big cats in zoos and circuses and runs an animal sanctuary.

Pesticide Action Network, 49 Powell St., Suite 500, San Francisco, CA 94102; http://www.panna.org/; Phone: 415-981-1771.

Pew Wilderness Center, Protecting America™s Wilderness and Natural Heritage, 122 C St., NW, Suite 240, Washington, DC 20001; http://www.pewwildernesscenter.org/; Phone: 202-544-3691.

Planned Parenthood Federation of America: http://www.plannedparenthood.org/. State and regional offices are listed along with publications and member services.

Population Action International, 1300 - 19th St., NW, 2nd Fl., Washington, DC 20036; http://www.populationaction.org/; Phone: 202-557-3400. Web site lists many publications.

Population Communications international, 777 United Nations Plaza, New York, NY 10017-3521; http://www.population.org/; Phone: 212-687-3366.

Population Connection (formerly Zero Population Growth), 1400 - 16th St., NW, Suite 320, Washington, DC 20036;

http://www.populationconnection.org/; Phone: 202-332-2200.

Population Institute, The, 107 Second Ave., NE, Washington, DC 20002; http://www.populationinstitute.org/; Phone: 202-544-3300.

Predator Conservation Alliance, P.O. Box 6733, Bozeman MT 59771; http://www.predatorconservation.org/; Phone: 406-587-3389. *The Home Range*, quarterly newsletter.

Primarily Primates, P.O. Box 207, San Antonio, TX 78291-0207; http://www.primarilyprimates.org/; Phone: 830-755-4616.

Pro Natura USA, 8123 Heatherton Ln., #104, Vienna, VA 22180; Phone: 703-641-5900.

Pro Natura International, 61, Green Ridges, Headington, Oxford OX3 8PL, United Kingdom.

Pro Natura Brazil, Ave., Beira Mar 406, Sala 708/709, Castelo, Rio de Janeiro 22021.060, Brazil.

Public Citizen and Public Citizen Health Group, 1600 - 20th St., NW, Washington, DC 20009; http://www.citizen.org/; Phone: 202-588-1000.

Public Interest Research Group (PIRG), 218 D St., SE, Washington, DC 20003; http://www.pirg.org/; Phone: 202-546-9707.

Organizations: Q Œ R

Rainforest Action Network, 221 Pine St., Suite 500, San Francisco, CA 94104; http://www.ran.org/; Phone: 415-398-4404. *World Rainforest Report*, newsletter for members. Rainforest teacher™s packet available.

Rainforest Alliance, 65 Bleecker St., New York, NY 10012; http://www.rainforestalliance.org/; Phone: 212-677-1900.

Rainforest Foundation US, The, 270 Lafayette St., Suite 1107, New York, NY 10012; Phone: 212-431-9098. Headquarters: Suite A5, City Cloisters, 196 Old St., London EC1V 9FR, United Kingdom; Phone: +44 (0) 20-7251-6345. Organization founded by rock artist Sting to promote conservation of rainforests and their native peoples.

Rainforest Relief, P.O. Box 150566, Brooklyn, NY 11215; http://www.rainforestrelief.org/; Phone: 718-398-3760. *Raindrops, Rainforest Relief Reports*, newsletter.

Raptor Center, The, Gabbert Raptor Building, 1920 Fitch Ave., St. Paul, MN 55108; http://www.raptor.cvm.umn.edu/; Phone: 612-624-4745. *Raptor Release*, newsletter.

RARE Center for Tropical Conservation, 1840 Wilson Blvd., Suite 402, Arlington, VA 22201-3000; http://www.rarecenter.org/; Phone: 703-522-5070. *RARE Center News*, newsletter.

Riverkeeper, P.O. Box 130, Garrison, NY 10524; http://www.riverkeeper.org/; Phone: 845-424-4149. Lists regional organizations specializing in particular rivers.

Rocky Mountain Institute, 1739 Snowmass Creek Rd., Snowmass, CO 81654-9199; Phone: 970-927-2851.

Environmentally friendly sources of energy, architecture, transportation, energy efficiency.

Organizations: S

Save America™s Forests, 4 Library Ct., SE, Washington, DC 20003; http://www.saveamericasforests.org/; Phone: 202-544-9219. *Save America™s Forests Magazine*

Save the Manatee Club, 500 N. Maitland Ave., Maitland, FL 32751; http://www.savethemanatee.org/; Phone: 407-539-0990.

Save the Redwoods League, 114 Sansome St., Room 1200, San Francisco, CA 94104-3823; http://www.savetheredwoods.org/; Phone: 415-362-2352.

Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Dr., La Jolla, CA 92093; www.sio.ucsd.edu/ ; Phone: 858-534-3624.

Sea Shepherd Conservation Society, 22774 Pacific Coast Hwy., Malibu, CA 90265; www.seashepherd.org; Phone: 310-456-1141.
Sea Turtle Restoration Project, P.O. Box 400, Forest Knolls, CA 94931; http://www.seaturtles.org/ ; Phone: 415-488-0370. Free catalog.

SeaWeb, 1731 Connecticut Ave., NW, 4th Fl., Washington, DC 20009; http://www.seaweb.org/ ; Phone: 202-483-9570.

Sierra Club, 85 Second St., 2nd Fl., San Francisco, CA 94105-3441; http://www.sierraclub.org/ ; Phone: 415-977-5500. *Sierra* magazine by subscription and on newsstands.

Sierra Club Legal Defense Fund: See Earthjustice Legal Defense Fund.

Sierra Club Student Coalition, P.O. Box 2402, Providence, RI 02906; http://www.ssc.org/ ; Phone: 1-888-JOIN-SSC.

Society for Animal Protective Legislation, P.O. Box 3719, Georgetown Station, Washington, DC 20007; http://www.saplonline.org/ ; Phone: 202-337-2334. This is the Animal Welfare Institute™s companion organization for legislative issues.

Society for Conservation Biology, 4245 N. Fairfax Dr., Arlington, VA 22203; http://www.conbio.org/ ; Phone: 703-276-2384. *Conservation Biology*, quarterly journal with articles by scientists on conservation, endangered species and related topics; and *Conservation Biology in Practice*.

Society for the Preservation of Birds of Prey, P.O. Box 66070, Los Angeles, CA 90066; Phone: 310-840-2322. *The Raptor Report*, newsletter.

Society of Tympanuchus Cupido Pinnatus, Ltd. (Society of the Greater Prairie Chicken), Stone Ridge II, Suite 280, Stone Ridge Dr., Waukeha, WI 53188; Phone: 414-523-3600. *Boom*, newsletter.

Solar Energy International, P.O. Box 715, Carbondale, CO 81623-0715; http://www.solarenergy.org/ ; Phone: 970-963-8855. *Home Power*, magazine.

Southern Environmental Law Center, 201 W. Main St., Suite 14, Charlottesville, VA 22902-5065; http://www.selcga.org/ ; Phone: 434-977-4090.

Stanford University Center for Conservation Biology: www.stanford.edu/group/CCB .

Student Environmental Action Coalition, National Office, P.O. Box 31909, Philadelphia, PA 19104-0609; http://www.seac.org/ ; Phone: 215-222-4711.

Suncoast Seabird Sanctuary, Inc., 18328 Gulf Blvd., Indian Shores, FL 33785; http://www.seabirdsanctuary.org/ ; Phone: 727-391-6211. Treats and rehabilitates injured seabirds, especially those who have swallowed fish hooks or have become entangled in fishing lines.

Survival International, 6 Charterhouse Bldg., London EC1M 7ET, United Kingdom; http://www.survival-international.org/ ; Phone: 00-44-20-7687-8700.

Organizations: T

Tiger Trust, The: www.fontayne.com/tigertrust/ . *Tiger News*, biannual journal.

TRAFFIC International, 219c Huntingdon Rd., Cambridge CB3 ODL, United Kingdom; http://www.traffic.org/ ; Phone: (44) 1-223-27723. *TRAFFIC Bulletin*, quarterly publication on wildlife trade.

TRAFFIC USA, 1250 - 24th St, NW, Washington, DC 20037; www.traffic.org/25/network6.htm ; Phone: 202-293-4800. Newsletter on wildlife trade; affiliated with World Wildlife Fund.

Trumpeter Swan Society, The, 3800 County Road 24, Maple Plain, MN 55359; www.taiga.net/swans/ ; Phone: 763-476-4663. *Bulletin of the Trumpeter Swan Society*.

Trust for Public Lane, 116 New Montgomery St., 4th Fl., San Francisco, CA 94105; http://www.tpl.org/ ; Phone: 415-495-4014.

Organizations: U Œ V Œ W

Union of Concerned Scientists, 2 Brattle Square, Cambridge, MA 02238; http://www.ucsusa.org/ ; Phone: 617-547-5552.

WhaleNet, 200 The Riverway, Boston, MA 02215; www.whalenet.org or http://www.wheelock.edu/ .

Whooping Crane Conservation Association, 1393 Henderson Hwy., Breaux Bridge, LA 70517; http://www.whoopingcrane.com/ .

Wild Canid Survival and Research Center, Washington University™s Tyson Research Center, P.O. Box 760, Eureka, MO 63025; http://www.wolfsanctuary.org/ ; Phone: 636-938-5900. *Wild Canid Center Review*.

Wild Sentry, The Northern Rockies Ambassador Wolf Program, Inc., P.O. Box 172, Hamilton, MT 59840; www.bitterroot.net/wild ; Phone: 406-363-7291.

Wilderness Society, The, 1615 M St., NW, Washington, DC 20016; http://www.wilderness.org/ ; Phone: 1-800-THE-WILD. *Wilderness*, magazine.

Wildlife Connection, The, P.O. Box 719, Jasper, AR 72641; Phone: 502-524-2396. Education and rehabilitation.

Wildlife Conservation Society, Bronx Zoo/Wildlife Conservation Park, 2300 Southern Blvd., Bronx, NY 10460; http://www.bronxzoo.com/ ; Phone: 718-220-5100. Virtual tour and information on the programs of the Wildlife Conservation Society to preserve rainforests in the Congo; saving endangered species. *Wildlife Conservation*, bimonthly magazine by subscription and on newsstands; http://www.wildlifeconservation.org/ .

Wildlife Society, The, 5410 Grosvenor Ln., Bethesda, MD 20814; www.wildlife.org; Phone: 301-897-9770.

Wildlife Trust (formerly US partner of the Jersey Wildlife Preservation Trust), 61 Route 9W, Palisades, NY 10964-8000; http://www.wildlifetrust.org/ ; Phone: 845-365-8337. *On the Edge*, a quarterly magazine for members.

Wolf Education and Research Center, The, P.O. Box 217, Winchester, ID 83555; http://www.wolfcenter.org/ ; Phone: 208-924-6960.

Woods Hole Oceanographic Institution, 360 Woods Hole Rd., Woods Hole, MA 02543-1541; http://www.whoi.edu/ ; Phone: 508-548-2219.

World Bird Sanctuary, P.O. Box 270270, St. Louis, MO 63127; http://www.worldbirdsanctuary.org/ ; Phone: 636-861-3225. Propagation and rehabilitation of exotic parrots and other birds.

World Conservation Monitoring Centre, 219c Huntingdon Rd., Cambridge CB3 0DL, United Kingdom; http://www.unep-wcmc.org/ ; Phone: 44 (0) 1223-277314. Affiliated with the International Union for the Conservation of Nature (IUCN) and World Wildlife Fund, it compiles information on endangered species and wildlife trade.

World Conservation Union: See International Union for the Conservation of Nature and Natural Resources (IUCN).

World Rainforest Movement, P.O. Box 1539, Montevideo 11000, Uruguay; www.chasque.apc.org/item ; Phone: +598-2-419-6292.
World Resources Institute, 10 G St., NE, Washington, DC 20002; www.wri.org; Phone: 202-729-7600.

World Society for the Protection of Animals (WSPA) Headquarters: 89 Albert Embankment, London SE1 7TP, United Kingdom; Phone: 44 (0) 20-7587-5000.
US: 34 Deloss St., Framingham, MA 01702; http://www.wspa-americas.org/ ; Phone: 508-879-8350. *Animals International* and *The Protector*, newsletters.

World Species List (many endangered species lists): www.envirolink.org/species .

World Wildlife Fund US, 1250 - 24th St., NW, P.O. Box 97180, Washington, DC 20090-7180; http://www.wwf.org/ ; Phone: 202-293-4800. *Focus*, newsletter; *Living Planet*, quarterly magazine.

Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC 20036-1904; http://www.worldwatch.org/ ; Phone: 202-452-1999. *State of the World* and *Worldwatch*.

Worldwide Fund for Nature, Avenue du Mont-Blanc, 1196 Gland, Switzerland; http://www.panda.org/ ; Phone:

+41-22-364-91-11.

Organizations: X Œ Y - Z
Yellowstone Ecosystem Studies, P.O. Box 6640, Bozeman, MT 59771; www.c-t-g.com/yellowstone ; Phone: 406-587-7558.

Xerces Society, 4828 SE Hawthorne Blvd., Portland, OR 97215-3252; http://www.xerces.org/ ; Phone: 503-232-6639. Newsletter concerning the preservation of butterflies and other invertebrates.

Zero Population Growth: See Population Connection.

Endangered Species Handbook

Video:

- Television Series
- Films as Educational Aids
- Films

chapters AWI search

sea turtle: Ursula Keuper-Bennett/turtles.org

Video

Television Series

Over the past decade, more and more nature programs are being produced for television. The interest shown by the public in these programs is growing. Some of these programs are described below, and special films on wildlife are reviewed in the Films section.

Discovery Communications Inc., which sponsors the Discovery Channel, Animal Planet, and other channels, shows many hours of natural history films each week. Animal Planet shows animal programs exclusively, some of which deal with endangered species. The channel has been very successful, and the new National Geographic channel has many wildlife and environmental documentaries. Other than the occasional National Geographic Society special aired on NBC, major networks do not have regular prime-time programs on the environment or wildlife. By contrast, PBS airs regular programs on these subjects. These programs, including Nature, NOVA, David Attenborough's Natural World and others, have been shown for decades, as PBS led the way in airing high quality, informative and beautiful programs on wildlife and natural history.

Animal Rescue. Syndicated.
This one-half hour weekly program gives many examples of people helping animals or, in some cases, animals helping other animals through various crises. Moose and deer that have fallen into freezing water are pulled to safety, oiled birds, injured turtles and starving sea lions are rescued and rehabilitated, and there are many stories about help for stranded or injured pets and domestic animals. Veterinary care is described, and much interesting information is given about positive examples of humane treatment of animals. At the end of the program, ARK gives general tips about helping animals

Assignment Discovery. Discovery Channel.
On weekdays during the school year, this one•hour program is shown between 9 and 10 a.m., with a format designed especially for teachers to tape for use throughout the year. At least once a week, a program is dedicated to natural science. Commercials have been removed and the programs contain highlights from prime-time programs. Web page: www.discovery.com. There are also species sites such as "Lizards!": www.discovery.com/exp/lizards/lizards.html

National Geographic Explorer. MSNBC.
This weekly two-hour program highlights films by the National Geographic Society, as well as those of other film producers. Many of these films deal with endangered species and wildlife conservation. Some are distributed commercially by the National Geographic Society, but the majority is not commercially available. This program has an Internet page for more information on specials and programs shown: www.nationalgeographic.com

Nature. PBS.
One of the finest wildlife and natural history programs on television, Nature has high•quality photography, well-written and interesting narrative, and often, unusual subject material. Produced by WNET, the PBS station in New York, films produced by the British Broadcasting Co. (BBC), Survival Anglia, Partridge Films, Wolfgang Bayer and other producers are shown. The weekly one-hour programs are repeated. See reviews below. They are available from PBS (see Distributors list).

NOVA. PBS.
Produced by WGBH in Boston, MA, these one-hour films have garnered many awards. Programs relate to wildlife conservation, astronomy, sociology and many other subjects. Some NOVA films have centered on endangered species and habitats, such as the Great Barrier Reef and condors. They may be taped for classroom use within seven

days of broadcast. Videocassettes of the programs are available. NOVA teacher's guide, a semi•annual publication, presents discussions of the programs with quizzes and lesson plans. This may be subscribed to at www.pbs.org/nova/teachers/guidesubscribe.htmp or viewed on line at http://main/wgbh.org/wgbh/learn/teacherscenter. This site provides major projects, partner schools, professional development workshops and favorite links. The printed copy can be ordered from WGBH, 125 Western Avenue, Boston, MA 02134. Videocassettes can be ordered from: WGBH NOVA Videos, P.O. Box 2284, South Burlington, VT 05407•2284.

Today. National Geographic Channel.
This daily, hour-long program reviews natural history news, including some longer reports on endangered species and programs to aid them as well as environmental items of interest. The program also has items that are reflective of its magazine content, such as profiles of native tribes, country highlights and geography. It is the only such program on television since "Earth Matters," CNN's excellent weekly environmental news program, was cancelled.

Films as Educational Aids

Video involving endangered animals and plants is now of amazing quality and interest, an exciting trend. Films on disappearing wildlife are no longer focused on zoo animals, but on animals in the wild. This is extremely important in educating and motivating the public, as well as students, to preserve these vanishing treasures and their beautiful--but fragile--environments. As wildlife films grow in popularity, filmmakers are tackling ever more unusual challenges to find extremely rare animals or remote habitats, spending years to obtain magnificent footage. Some animals being captured on film have only just been described scientifically and have never before been filmed. The results are sometimes dazzling, with imaginative presentation. For the viewer and student, such fascinating subjects are not only educational, but provide a free trip to beautiful parts of the world where wildlife can be seen in natural habitats, exhibiting natural behavior not seen in zoo animals. Many endangered animals inhabit magnificent landscapes, from alpine meadows framed by snowy mountains in New Zealand to remote rainforests in Brazil or Madagascar. The best of these films have been made by cinematographers with a great deal of natural history knowledge or guidance, showing distinctive features of animals and plants, as well as threats to their survival and habitats. To see a Harpy Eagle, the largest eagle in the world, at close range at its nest more than 100 feet above the forest floor, caring for chicks and arriving with prey as large as sloths, is an exciting spectacle that will also encourage the preservation of this endangered species.

Some classic films combine information with an artistic eye and a narrative that provides viewers with a new perspective. Among these are "Baobab: Portrait of a Tree;" "Korup--An African Rainforest;" "The Living Planet" series; "Among the Wild Chimpanzees;" "Reflections on Elephants;" and "The Private Life of Plants." Such films provide eloquent and intelligent lessons that teach not only basic information about the habitats and species focused upon, but argue strongly in favor of their conservation. Saving wild places and habitats is the most important tool in preventing extinctions, and these films make this clear. Some films also show the tragic slaughter of rare animals and destruction of habitats, the better to call attention to why these activities must be stopped and to make real the plight of nature. Lessons about biological diversity are an intrinsic part of many films as well, although this has often been more intimated than stressed openly.

The viewer who sees the final product rarely imagines the hardships and imaginative use of technology that went into the film's production. "Wildfilm," a 1995 documentary (Partridge Film Ltd. and Television New Zealand Natural History Productions, shown on PBS), describes how natural history films are made, with many delightful encounters between filmmakers and animals. It divulges many of the secrets used, such as a remote-controlled miniature helicopter equipped with a camera that provides aerial views of mountainous terrains and night filming of difficult

subjects. Difficulties included cameras freezing while filming Emperor Penguins at 60 degrees below zero F. Technological advances now permit microphotography by film producers, such as Oxford Films, of natural worlds invisible to the naked eye. Superb underwater photography is also capturing coral reef creatures and the fantastic animals that live in deep-sea habitats. Another innovation is the approach used in IMAX films, projecting many cameras on giant screens, giving the viewer a dramatic sense of entering into the film. They are shown at some 20 specialized theaters, most of which are in science museums.

In some cases, filmmakers risk their lives to obtain their final products. In 1993, one of the greatest wildlife and nature cinematographers, Dieter Plage, fell to his death from a film platform 150 feet up a tropical forest tree. The dangers of this vocation also include attacks by wild animals, accidents, tropical diseases, and even clashes with local people. Many of these filmmakers are dedicated conservationists, and their portrayals of wildlife contribute to conservation efforts. Several organizations convene wildlife film festivals, awarding prizes in various categories, and occasionally, Academy Awards are presented to wildlife filmmakers. Many of the reviews below give credit to the filmmakers, the best of whom must combine qualities from intellectual curiosity to artistry of presentation, along with physical endurance.

Some filmmakers have been criticized in the past for staging dramatic scenes for wildlife movies, often harming or killing animals in the process. Such criticism was sometimes justified, and stricter permit regulations on the part of various countries have reduced some of the more flagrant examples of past abuses. In other cases, filmmakers are witness to extreme suffering by animals because of accidents, disease or starvation. Many national parks prohibit human intervention. However, in some situations, people created the crises.

One tragic case involved a group of Cheetahs in Namibia. First, a Lion killed a finanny,fl or non-breeding female Cheetah, in this group, who helped watch the cubs; then the breeding female died soon after of anthrax. Three of the five cubs quickly died of starvation, being too young to hunt alone, and the two surviving male cubs set out alone on the sunbaked desert. One emaciated cub collapsed, while the other tried desperately and unsuccessfully to catch a Bat-eared Fox. The weaker cub was filmed as it tried valiantly to raise itself from the ground when jackals arrived, who had sensed his condition. Unable to remain standing, the cub's hindquarters gave way, and he fell to the ground, his eyes wild and unfocused. The filmmakers, nose to the ground, recorded his death.

Cheetahs are highly endangered and declining throughout their range, persecuted in southern Africa by ranchers whose careless management of livestock caused the deaths of a mother and her cubs. Intervention in this case was warranted. They could have easily captured the skeletally thin and weak Cheetah cubs. There are two rescue centers in Namibia for these endangered and beleaguered wild cats. This film, "Etosha, Africa's Untamed Wilderness," is part of Reader's Digest's Living Edens series, produced in 1997 by ABC/Kane Productions, and filmed by Adrian Warren and Justin Maguire. A code of ethics for wildlife filmmakers should include interventions in such cases.

Although more and more filmmakers are traveling to record the diversity of Borneo, Madagascar, Costa Rica and other species-rich environments, too many films are still being made of large East African mammals, such as wildebeest and their predators. Many fascinating areas have not been visited by cinematographers. Rainforest birds, for example, are rarely filmed, with a few exceptions, nor are the endangered temperate forests of Australia or South America. Many of the "hot spots" of biological diversity, such as Madagascar, Mauritius, New Zealand and southwestern India, have been the subjects of films, but other areas, including the Philippines, South Africa, New Caledonia, and the Ecuadorian highlands, have almost never been seen in nature films. Yet these areas are teeming with extraordinary wildlife and plants that would fascinate viewers.

Rare trees and plants are also being ignored, to their detriment. Many of the most unusual trees of the world, from the Monkeypod Tree of South America to the towering Kauris and their relatives of New Zealand, Australia and New Caledonia, are highly endangered, and visually stunning. The latter are survivors of the supercontinent Gondwana, as are the rare protea flowering plants of South Africa. Yet many of these plants are on the verge of extinction, being logged, overcollected or otherwise destroyed. A film about these fragments that have lived on Earth for 100 million

years or more, some pre-dating the dinosaurs, would be extremely interesting and important for their conservation by raising awareness of their plight. The value of trees in producing oxygen, holding the soil in place, preventing floods and providing habitat for wildlife is of vital importance, yet the last of the old-growth forests, the richest in species of all forests, are being cleared for agriculture and wood products. This subject--as well as the crucial role that invertebrates play in symbiotic relationships with plants, pollination and other ecological roles--needs far more attention from filmmakers. Catastrophes such as floods and landslides are often the result of wetland filling and forest clearing, yet films on these subjects usually dwell on the sensational aspects, stressing the dramatic footage of houses and vehicles destroyed and survival stories. Nature's great value to human society is not understood by the majority of people, and several fascinating books have been written to explain and even place a monetary value on natural ecosystems vs. the value of exploited natural resources. Such studies would make fascinating films and provide logical arguments to oppose the constantly accelerating trend toward commercial exploitation and destruction of the environment worldwide.

The value of films in providing a record of endangered species was made clear in the film, "Rain Forest," by the National Geographic Society. The brilliant Golden Toads of Costa Rica, seen in their mating gatherings, disappeared a few years later and have not been seen since. Video of the great African Elephant herds prior to the 1980s slaughters represents another example of wildlife spectacles that may never return because of the increase in human population and development of wildlife habitat. As wilderness areas shrink, films should be made of these regions, both aerially and at ground level, to record these precious remnants of the entire planet as it once appeared, to argue for their protection and to inventory their native wildlife and plants.

For many films, especially those shown on PBS, companion books and teaching guides that provide additional information have been written. Books and articles on endangered species become all the more interesting and relevant after seeing films on the same subject. By combining films and literature on endangered species, both students and the public in general can grasp the essentials of the major threats to endangered species and the many fascinating and unique species that are in imminent danger of disappearing.

A learning program on Madagascar, for example, can be brought to life when seeing films of the delightful lemurs and other native wildlife, accompanied by books such as Ken Preston-Mafham's 1991 book, *The Natural History of Madagascar*, and other references on the subject in the Books and Publications section. (See descriptions of Madagascar and its wildlife in the Madagascar and Other Islands chapter of this book.) Many films on Madagascar and its wildlife are reviewed below.

The last wilderness retreats of numerous endemic and rare species are in danger from logging, livestock and other exotic species, mining and other destruction. Some are so breathtakingly beautiful that it is difficult to comprehend that for many people, these regions and their fragile wildlife and plants are without value or importance. The majority of people on Earth are struggling to survive and do not understand that the loss of these places can affect them. As ecosystems become unbalanced, food supplies are threatened by droughts, and poverty increases. Much needs to be done to aid these people to live in harmony with nature and to provide them with financial aid. Some of these films address these issues and provide solutions. Films can be of great importance in teaching people around the world about the crises that are facing us as the last old-growth forests are cut down, and the loss of biological diversity, which stabilizes nature, will cause a myriad of other ecological disasters. Films reviewed here show the complexity, beauty and majesty of many types of forests--cloud, temperate and tropical rain, and deciduous--and their importance in absorbing carbon dioxide and producing oxygen, as well as providing habitat for untold numbers of animals. For nearly every ecological crisis now facing us, a film explains the problem--at least its basics--and, above all, illustrates what is being lost because of ignorance and greed.

Films can also show the endearing sides of wildlife that touch the heart, the devotion of elephants for one another, the gentle affection between lemurs, chimpanzees and other animals. Their intelligence, athleticism and other qualities can amaze the viewer. Our compassion is aroused when we see films of animals dying in traps, harpooned, shot, orphaned or otherwise suffering. The many films shown in North America about the Gray Wolf have inspired a

public interest in the species' conservation and sparked a new ecotourism around the reintroduced wolves of Yellowstone National Park. Although some people, primarily livestock ranchers, remain prejudiced against wolves, they have become a minority. This contrasts dramatically with the situation in other parts of the world where wolves are being driven to extinction because of misunderstandings about their ecological importance and their supposed threats to humans and livestock. Many films have shown the loyalty and devotion wolves display to one another, even at the risk of their lives. These qualities are the very ones esteemed in dogs, who were descended from wolves.

Without a film record of animal behavior, such as that of the wolf, the qualities described by observers and scientists might be treated with more skepticism, as they were in the past. It is difficult, for example, for those who have portrayed the wolf as a vicious and dangerous animal, to maintain this view in the face of film documentation that provides a fact-based view. For this reason, films can be a more powerful and influential educational tool than the written word.

Endangered Species Handbook

Books and Publications:

- Bibliographies, Source Guides and Reference Services
- Biodiversity, Environmental Problems and Conservation
- Endangered Species - General
- Endangered Species Lists
- Zoos, Captive Breeding, Recovery and Reintroduction
- Non-native Species Introductions
- Wildlife Trade and Poaching
- General
- Habitats
- Regional

Books

Bibliographies, Source Guides, Reference Services

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