Wetlands, Biodiversity and the Ramsar Convention

Wetlands, Biodiversity and the Ramsar Convention: the role of the Convention on Wetlands in the Conservation and Wise Use of Biodiversity

edited by A. J. Hails

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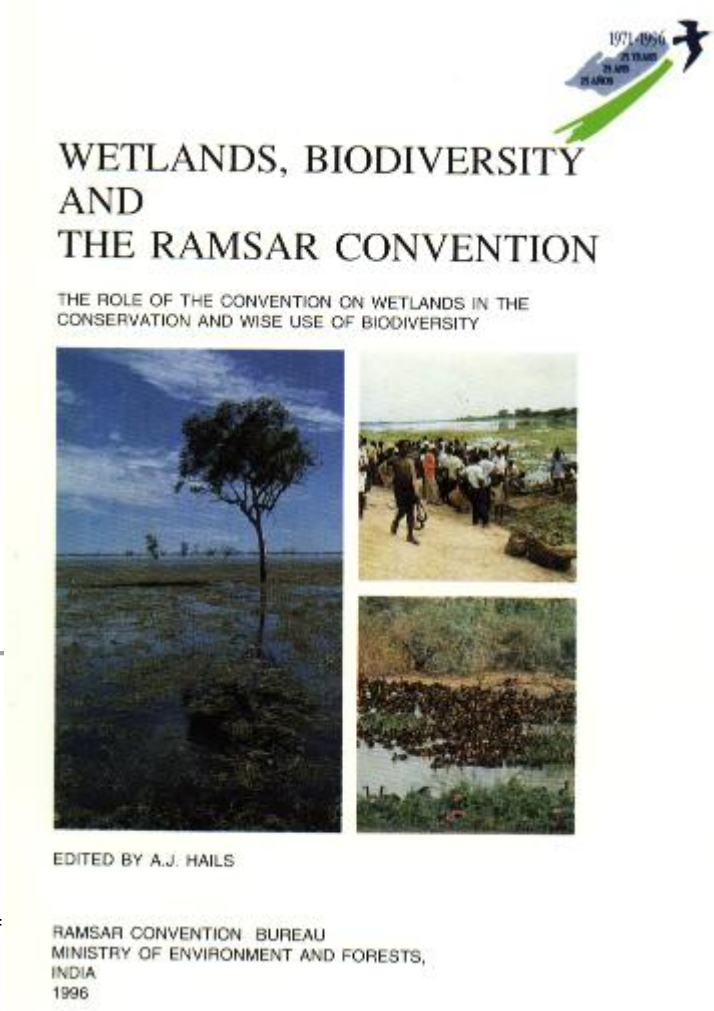

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Foreword

Wetlands are among the most productive life-support systems in the world and are of immense socio-economic and ecological importance to mankind. They are critical for the maintenance of biodiversity and perform a great role in the biosphere. Ironically, wetlands have been perceived as wastelands associated with disease, difficulty and danger. Emphasizing the negative impacts and ignoring their importance, these habitats were considered obstacles in the path of progress and hence drained, filled, despoiled and degraded for economic gains. The wetland loss has been responsible for bringing to the verge of extinction countless species of animals and plants. Inadequate understanding of the crucial role and utility of wetlands is a matter of serious concern.

Recognizing the importance of wetland resources, the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) has been instrumental in world wide action at the governmental level for conservation and wise use of wetlands. In its first 25 years, the Ramsar Convention has played an important role in promoting awareness of wetlands and providing technical support to governments for conservation and management of these ecosystems on a sound ecological basis. By implementing the Strategic Plan recently adopted by the 6th Conference of Contracting Parties, the Ramsar Convention's work will become more closely related to the broader concerns of the Convention on Biological Diversity and the UN Commission on Sustainable Development.

I am happy to note that the RamsarConvention towards its 25 year celebration has brought out this publication on Wetland Biodiversity. The publication covers a wide range of issues relating to the status, diversity, conservation issues, policies and management aspects related to wetland biodiversity for all the seven regions of the world as identified by the Ramsar Convention. The overview of wetland biodiversity followed by some case studies from each of these regions and the role of the Ramsar Convention to promote conservation of wetlands are highlighted in the publication.

I hope that the publication would be useful to conservationists, policy planners, researchers and other interested groups.

Captain Jai Narain Prasad Nishad
Minister, Environment and Forests, India

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Ramsar's Secretary General, Delmar Blasco, ably led the Bureau staff in their supportive role throughout the preparation ofthe text and, in particular, thanks are due to the Bureau's Technical Officers, Montserrat Carbonell, Tim Jones, Tom Kabii, and Satoshi Kobayashi, and the Bureau's Senior Policy Advisor, Mike Smart, for their technical help and advice. Thanks are also due to Dwight Peck who prepared the maps and gave invaluable assistance with the production of the text,

Valerie Higgins who helped in the final preparation of the text, and Mireille Katz who gave constant support and encouragement throughout the project. Many other people have helped in various small but significant ways and I am indebted to them all.

The Ramsar Bureau extends its thanks to the many individuals who willingly provided photographic material for the publication and to Dr. C. L. Trisal, Ministry of the Environment and Forests, India, who gave considerable assistance in the production of the book.

Sandra Hails

Editor's Note

Nomenclature

Since birds are both conspicuous and well studied components of wetland animal communities they are frequently mentioned in the chapters which follow. As a consequence it was decided to standardise the scientific names of the species, avoiding some of the regional variations which would otherwise have arisen. We used as our standard text:

Sibley, Charles G. and Monroe Jr, Burt L. 1990. *Distribution and Taxonomy of Birds of the World*. Yale University Press, New Haven & London.

To preserve the regional character of the chapters, we left the common names of birds as they were defined by the authors; this has produced some inconsistencies between chapters. We encouraged authors to include common names of both animals and plants wherever possible but since the latter are less frequently used by botanists, they do not always accompany the scientific names of the plants.

Conservation Status

Many authors made reference to the number of threatened or endangered animal species recorded in the large number of wetlands referred to in this publication. Since this was variable, reflecting local, national or regional levels of threat, we attempted to make the statements more clear and furthermore to highlight the number of wetland animal species which are considered globally threatened. Thus we have indicated within the text those species which appear in the *1994 IUCN Red List of Threatened Animals*. The full reference for this publication is:

Groombridge, B. (ed.). 1993. *1994 Red List of Threatened Animals*. IUCN, Gland, Switzerland and Cambridge, U.K.

In the European chapter we deviated slightly from this system by identifying those birds species which were considered of Global Conservation Concern or which had an Unfavourable Conservation Status in Europe in BirdLife International's 1994 assessment of birds in Europe, i.e. those that were included in Categories 1-3. The full reference for this publication is:

Tucker, G.M. and Heath, M.F. 1994. *Birds in Europe: their Conservation Status*. Cambridge, U.K.: BirdLife International (BirdLife Conservation Series No.3).

CONTENTS

CHAPTER 1

WETLANDS AND BIODIVERSITY

By Peter R. Bacon, Department of Zoology, University of the West Indies, Trinidad

Introduction

The combination of aquatic and terrestrial conditions that produce what we describe as '**wet-lands**' makes these ecosystems among the most complex in the world. Within a wetland, the environmental characteristics are determined largely by hydrologic processes which may exhibit daily, seasonal or longer-term fluctuations, in relation to regional climate and geographic location of the site. These factors produce a great range of wetland types globally, the majority of which have extremely variable conditions in the many habitats which they contain (Table 1). As a consequence, the variety of living organisms which has adapted to the different wetland habitats tends to be high, with all major groups of plants and animals present.

Table 1. Range of natural habitats within different temperate and tropical wetland ecosystems

Inland freshwater lake/USA (1)	.
Rock bottom	Unconsolidated shore
Unconsolidated bottom	Emergent marsh wetland
Aquatic bed	Forested wetland
Rocky shore	.
.	.
Basinal freshwater wetland/Trinidad (2)	.
Saturated forested wetland	Intermittently exposed unconsolidated shore
Tidally saturated forested wetland	Semi-permanently flooded aquatic bed
Permanently flooded emergent herbaceous wetland	Channels and pools
Seasonally flooded emergent herbaceous wetland	Marginal terra firma
.	Inlier terra firma
.	Secondary forest and disturbed marsh
Coastal wetland/Surinam (3)	.
Stagnant brackish and hypersaline pools	High Fiddler-crab zone of tidal mudflats
Drying up lagoons	Firm and tough clay banks
Tidal lagoons	Lower foreshore sandy beach
Soft tidal mudflats	Back slope sandy beach
.	Dry firm clay

1 Cowardin *et al*., 1992; 2 Bacon, 1988; 3 Swennen and Spaans, 1985

Box 1 documents the biodiversity of Nariva Swamp, Trinidad, exemplifying the variety of organisms occurring at just one site. The remainder of this chapter examines the factors responsible for the biodiversity of wetlands, such as Nariva Swamp, and the components of such biodiversity. By reference to several tropical and temperate sites, it considers some of the ecological and economic implications of loss of this biodiversity and concludes by discussing why the protection of wetland biodiversity is of both national and international importance.

Diversity and Productivity of Wetland Plants

A variety of topographic gradients exist in wetlands and these influence the nature of the colonising vegetation. Gradients exist between terrestrial uplands and flooded basins, lakes or river beds. In coastal situations they occur in relation to tidal fluctuations which produce great habitat variability on the shoreline (e.g. Table 1), as they do across lagoons and the zones of nearshore coral reefs. Wetland vegetation may respond to the topography and hydrology with a distinct zonation pattern formed by the dominant plant species, particularly in tidal situations, or produce a complex mosaic of plant communities around minor local variations in height.

Zonation patter in a coastal wetlands, Carriacou: from land in foreground through salina, black mangrove, red mangrove and tidal channel to the open sea. *(Photo: Peter Bacon)*

Further variability is introduced to inland wetlands by seasonal fluctuations in the rainfall or inundation pattern. The area covered by a wetland may expand and contract with the seasons and thus produce a border of plant communities adapted to alternate flooded and dry conditions. The 'varzea' wetlands of the Amazon floodplain, for example, extend for hundreds of kilometres and show a distinct change in the degree of adaptation of the plant species as one goes from the permanent river channel to the upland terra firma. In temperate wetlands, spring flood and summer drawdown introduce a similar variability in terms of the nature and availability of plant habitats. As a result, wetlands support diverse plant communities, particularly the inland wetlands associated with major drainage systems in both tropical and temperate regions. The US National List of plant species that occur in wetlands

compiled by Reed (1988) included 6,728 species. This diversity is reflected at individual sites, such as the 243km2 Cache River-Cypress Creek wetland, a Ramsar site in Illinois, USA, where 138 woody plants, 251 non-woody vascular (flowering) plants and 11 ferns were present (USFWS, 1994). However, under more extreme conditions, such as the arctic Tundra, high mountain peat bogs and hypersaline saltmarshes in the dry tropics, the diversity is lower, even though a range of highly specialized plants will be present.

BOX 1: **THE BIODIVERSITY OF NARIVA SWAMP, A TROPICAL WETLAND BASIN**

Within its 60 km2 basin on the east coast of the small tropical island of Trinidad, the Nariva Swamp contains some 15 distinct communities of flowering plants with over 300 species. The plants range from submerged and rooted aquatic plants in flooded marsh areas, through stands of freshwater swamp forest on elevated banks and channel margins, to mangroves lining tidal channels on the seaward side. The plant communities form the basis of a food web supporting more than 600 species of animals (microfauna and meiofauna not included).

Range of plant communities in Nariva Swamp

SWAMP FOREST	
Mangal	(Sclerophyll, brackish water forest; dominated by mangroves)
Swamp Wood	(Orthophyll, freshwater forest), Mixed Swamp Wood, Immortelle Swamp Wood
Palm Swamp Forest	(Megaphyll, freshwater forest; dominated by palms), Moriche Palm Swamp Forest, Royal Palm Swamp Forest, Roseau Palm Swamp Forest
EVERGREEN SEASONAL FOREST	(on islands and wetland margins)
SEMI-EVERGREEN SEASONAL FOREST	(on islands and wetland margins)
LITTORAL WOODLAND	(Tree vegetation on seaward border)
MARSH	Sedge Marsh (*Cyperus*), Aroid Marsh (*Montrichardia*), Reed Marsh (*Phragmites*), Floating Marsh (Water Hyacinth, Water Fern, lilies)

Freshwater habitats: Open channel bordered by low marsh with swamp forest in the background, Nariva, Trinidad.*(Photo: Peter Bacon)*

Animal Groups and Species Recorded at Nariva Swamp

Phylum/Class	Total	Aquatic-Fresh	Aquatic-Brackish	Non-aquatic
Crustaceans	31	1	30	0
Insects	243	9 & larvae*	0	234
Arachnids	28	0	0	28
Molluscs	17	8	7	2
Fish	33	25	8	0
Amphibians	19	19	0	0
Reptiles	39	9	2	29
Birds	176	- waterbirds 32 -		144
Mammals	45	2	1	42

*** Larvae of non-aquatic insects**

(Source: Bacon et al., 1979)

Many wetland plants, or hydrophytes, grow in dense and prolific stands. For example, in Papyrus *Cyperus papyrus* swamps in Lake Naivasha, Kenya, Jones (1983) reported a harvestable standing crop of 30 tonnes per hectare compared with only 10 tonnes per hectare of grass from the finest European pastures. After harvest, this amount of Papyrus biomass was replaced in about nine months. Table 2 shows that many other types of wetlands are highly productive. The ready availability of water, which transports nutrients and removes waste products, and the frequent association between plant roots and microscopic organisms able to use nitrogen, allow wetland plants to grow rapidly and produce large quantities of organic matter. In tropical wetland plants, such as mangroves, this primary production can go on all year and reach levels comparable to the most intensively mechanised agricultural production, for example sugar cane crops. Plants play a critical

role in the structure and productivity of coral reefs in nearshore wetland environments. In many areas, the reefs can be described as 'cor-algal' reefs because of the close association between the corals (animals) and species of algae (plants). Other algae living in the coral tissues aid in the production of organic matter and are largely responsible, thus, for the high productivity of the reefs.

An aerial view of seasonal drawdown zone on a lake margin. ***(Photo: Peter Bacon)***

Table 2: Productivity of selected wetland ecosystems

Wetland type	**Location**	**Annual production, tonnes per hectare per year (above ground only)**
Estuarine mangrove	Sri Lanka	12
Tidal saltmarsh	Louisiana, USA	14
Riparian forest	Louisiana, USA	14
Freshwater (reed) marsh	Denmark	14
Freshwater (Papyrus) marsh	Kenya	30
Freshwater (reed) marsh	Wisconsin, USA	34
Tropical seagrass bed	Caribbean	70

(Sources: Amarasinghe and Balasubramanian, 1992; Hopkinson et al., 1980; Conners and Day, 1976; Anderson, 1976; Jones, 1983; Klopatek, 1978; Vicente, 1992)

Diversity of Animals in Wetlands

The species diversity and high production levels of wetland plants support even more diverse animal communities. The vegetation distribution patterns and water level fluctuations make a range of continuously changing wetland habitats available at different times of the year to aquatic, terrestrial

and arboreal animals. Wetlands support a wide variety of grazing and browsing animals, including several large mammals such as African Buffalo *Syncerus caffer*and Hippopotamus *Hippopotamus amphibius* in Africa, Capybara *Hydrochaeris hydrochaeris* and manatee *Trichecus* spp. in the Neotropics, Asian Water Buffalo *Bubalus bubalis* in Asia and Moose *Alces alces* in North America and Eurasia. Many species of rodent, such as the beaver *Castor* spp., Muskrat *Ondatra zibethicus* and Nutria *Myocastor coypus* in North America and Europe also depend on wetlands. A number of invertebrates, particularly snails and crustaceans, and some fish, such as Grass Carp *Ctenopharygodon idella*, graze on water plants and convert these to animal biomass, in some cases impoverishing wetland vegetation. Herbivorous diets are often generalized, but some South American fish feed exclusively on fruits from swamp forest trees and, thus, aid in seed dispersal. On coral reefs, a variety of green, red and brown seaweeds provides food for a great diversity of invertebrates and fish. Some of these, such as damselfish (Pomacentridae), behave like gardeners by protecting and trimming the plants that they hide among and feed upon. The range of plant species in the different wetlands, and their flowers, fruits and seeds, ensures a rich diversity of associated animals.

However, much of the vegetable material produced by wetland plants does not enter food chains directly. In mangrove swamps, for example, only about 10% of leaf production is grazed by snails, crabs and insects, with the remaining 90% falling into the water where it decomposes. Decomposition is brought about initially by microbes, largely marine bacteria and fungi, which break up the leaves and other plant parts. Microbes not only reduce the vegetable matter to smaller and smaller particles of detritus, but they increase the protein content by their presence and make the particles increasingly attractive to a wide variety of aquatic invertebrates. Similar processes occur in other types of wetlands, particularly many inland and tidal types in which decaying plant materials tend to accumulate before they can be consumed. The litterfall of dead leaves, flowers, fruits and twigs may be up to 17 tonnes per hectare per year in riverine and estuarine wetlands (Lugo *et al.*, 1990). The result of such litterfall is the production of a complex detritus-based food web which supports a great diversity of invertebrates, fish and amphibians, with fishes, frogs and toads being characteristically associated with wetlands. Larger predatory reptiles, birds and some mammals feed on the abundant food resources supported by decomposing plant parts. Characteristic wetland predators include crocodilians, freshwater turtles, the Anaconda*Eunectes murinus*, otters, dolphins and waterbirds. Wetlands of the Ebro Delta in Spain support 48 resident species of fish, 29 species of amphibians and reptiles, 27 mammals and 46 resident or migratory birds (MAPA, 1991) and this important Ramsar site forms one of the European case studies.

Many different kinds of birds with a wide range of feeding and breeding habits are found in wetlands. Among the 104 species recorded in the Black River Morass, Jamaica, were 11 seabirds, 36 waterfowl, 7 birds of prey, a kingfisher and 49 forest birds (Bacon, 1987); while 251 species have been found in the Cache River Basin, Illinois, USA (USFWS, 1994). According to Weigers (1990)

some 40 species of birds commonly breed in the somewhat restricted wetland forests in Western Europe. In the case study of the St. Lucia estuarine system of South Africa (a Ramsar site), some 350 species of birds are reported, including 90 species of waterfowl, such as ducks, geese, two species of flamingo and 15 species of herons and egrets.

An aquatic algal-invertebrate community on a mangrove root, Jamaica *(Photo: Peter Bacon)*

Many wetlands have such abundant food resources (both living plants and their decomposition products) that they can be utilized by species other than the permanent residents. Entry by 'visitor species' serves to increase further the diversity of animals that may be seen in wetlands from time to time. The life cycles of many species of marine shrimps include a period spent feeding in coastal estuaries or marshes. Several marine fish spawn in mangrove swamps or use these habitats as a nursery for their young because of the ready availability of small food materials and the security provided by mangrove roots. In addition, mangrove swamps are used for nursery and feeding by a range of coral reef-inhabiting species, while the reefs provide sheltered conditions along the coast which encourage mangrove establishment; this suggests that these associated wetland types are mutually supportive.

Migration into wetlands to benefit from food or favourable habitat conditions does not occur only in aquatic species, such as shrimp and fish. Many freshwater environments show seasonal fluctuations in water level which influence grazing and other feeding behaviour. Seasonal drawdown in water level permits the movement of animals, including livestock and their herders, into wetland basins, where they utilize the abundant, lush plant resources. In the Nariva Swamp, Red Brocket Deer *Mazama americana*, Collared Peccary *Tayassu tajacu*and Agouti *Dasyprocta aguti* and smaller rodents migrate from the swamp margins and interior islands during the dry season and occupy habitats populated by aquatic species at other times. In effect, any area of the swamp basin will support two different faunas at different times of year, thus increasing the diversity of animals which can be supported by one set of resources. Movement of herders into wetlands as flood waters retreat and fresh grazing areas become available, is discussed in the case study of the sebkhas of North Africa in a later chapter.

Many wetlands provide habitat for other important faunal components, serving as resting and feeding stations along migratory flyways for ducks, waders and shorebirds which benefit from the diversity of food organisms. The seasonal influx of passage migrants serves to increase the biodiversity of many wetland sites. In their study of coastal wetland habitats in Surinam, South America, Swennen and Spaans (1985) found more than 75% of the foraging waterfowl were migrants of northern origin, with only a minority being local resident species. For the eight families studied in an area of just 736ha of these rich and varied coastal wetlands they found 15,678 waterfowl belonging to 40 species dependent on the wetlands during the tropical part of their life cycle. This example shows that the migratory component of the bird life of wetlands is important, not only in terms of species diversity but in numbers of individuals. Similarly, the 24,000ha Cache River Basin in North America provided wintering habitat annually for nearly 200,000 Canada Geese *Branta canadensis*, 35,000 Snow Geese *Anser caerulescens* and 26,000 ducks which would breed further north (USFWS, 1994). The value of wetlands as habitat for migratory birds is documented many times in the regional case studies.

Wetlands support a variety of waterbirds - pelicans and sandpipers at Banc d'Arguin National Park, Mauritania. ***(Photo: J. Trotignon, Ramsar Library)***

The Economic Value of Wetland Biodiversity

Wetland plants are a major source of materials on which large numbers of people depend, particularly in the subsistence economies of tropical countries. In addition to the variety of goods produced (Table 3), the quantities exploited are impressive. Mangrove trees annually produce 7,400m3 of charcoal and 400 tonnes of bark for tanning in Panama and 120,000m3 of firewood in Honduras, while 80% of households in Nicaragua use mangrove wood for cooking (Lacerda, 1993).

Throughout the world, wetlands produce a range of animals of commercial importance, particularly as food, skins and for sport and the ecotourism business. Thus, inland wetlands in Africa produce over 1.5 million tonnes of fish annually, with a further 1.0 million tonnes from coastal marine areas. At least one million fishermen and perhaps five million workers in processing, transportation and market activities depend on these fisheries (Bernacsek, 1992). Twenty percent of commercial fish in Australia are caught in mangrove swamps; 45% were strictly dependent on mangrove resources, while 35% of mangrove dwelling species were food for commercial marine species (Robertson and Duke, 1987).

Table 3. Economic uses of tropical wetland plants (not in order of importance)

Construction materials (Housing & industry) Scaffolding, House beams & rafters, Flooring & panelling, Thatch & matting, Chipboard, Furniture, Fencing, Bridges, Posts, Tool handles, Water pipes, Packing boxes, Boats, Dock Pilings, Railroad ties, Mine pit props	**Medicines** (from fruit, sap, bark, leaves) Diuretics, Purgatives, Astringents, Febrifuges, Vitamines (mainly B group) Treatments for: Arthritis, Leprosy, Catarrh, Rheumatism, Skin rashes, Haemorrhage, Haemorrhoids, Snake bite, Tuberculosis
Fuel Firewood, Alcohol, Charcoal, Wood (curing fish, smoking rubber & firing bricks), Peat	**Textile & leather craft** Synthetic fibre (rayon), Dyes for cloth, Tannin for leather preparation (tanning)
Fishing materials Poles for fish traps, Branches - fish attracting devices, Floats, Fish poisons, Dye for nets, Tannin - net & line preservation	**Agricultural, horticultural & aquacultural products** Fodder, Fish feeds, Green manure, Peat/compost/fibre, Landscape plants, Plantings for coastal protection, Ornamental pond plants, Insect repellent
Food & beverages Sugar, Vinegar, Honey, Alcohol, Cooking oil, Tea substitutes, Fermented drinks, Masticatories, Condiments from bark, Vegetables from fruit, propagules & leaves	**Miscellaneous** Contraceptives, Aphrodisiacs, Cigar substitutes, Drilling lubricant, Matchsticks, Paper (various kinds), Hairdressing oil, Waxes, Incense, Glues

World trade in crocodilians from tropical and sub-tropical wetlands peaked in the 1960s at over 10 million skins per year, declining to a present volume of 1.5 million. In Venezuela alone the harvest of caiman skins and meat was valued at US$9.0 million in 1989 (Thorbjarnarson, 1991). The major part of bird hunting in all parts of the world is based on wetland habitats, with significant numbers taken in some areas (Table 4). Of the millions of fish, waterfowl and mammals hunted in North America, all the fish and more than 50% of other groups come from wetlands. In the Caribbean, parks and protected areas containing wetlands have functioned as major tourist attractions for many years, particularly for their bird life. They include the Caroni Swamp, Trinidad, the Flamingo Sanctuary, Bonaire, the Lagoons of Humacao, Puerto Rico, and the Virgin Islands National Park, which includes extensive shorebird and coral reef habitat. Annual recreational values of Caroni Swamp and the Virgin Islands National Park have been valued at US$1.0 and US$23.4 million respectively (Bacon, 1987). The major part of the foreign exchange earnings of the Turks & Caicos Islands comes from tourism based on coral reef diving. The large sport hunting industry and the rapidly expanding ecotourism sector have a multiplier effect on the economy through expenditure on transport, food, camping gear, hunting and fishing gear, license fees, photographic supplies, visitor facilities and related goods and services. Wetland faunas are, thus, of major economic importance globally.

Crocodilians play an important ecological role in wetlands: their meat and skins are of commercial value as well. ***(Photo: Peter Bacon)***

Table 4: Estimated numbers of wetland birds killed by hunters in selected parts of Asia

Country/Region	Bird Group	Numbers per annum
China (Lake	Coots	3,900

Shengjn)		
	Ducks	14,300
	Geese	200
Indonesia	Ducks	2,400
	Herons	38,000
	Others	3,600
Japan (1981)	Ducks	694,646
USSR (E. Siberia)	Ducks	3,420,000
West Java (Cirebon)	Crakes and rails	170,000

(After Parish and Howes, 1990)

Not all wetlands produce all types of resources, of course, but most will produce a wide variety, particularly larger sites like the Pantanal of Brazil, the Florida Everglades, the Kafue Flats in Zambia and the 6,000km2 Sundarbans in Bangladesh and India which are the subject of a case study. The economic value of many wetlands is decreased by the presence of noxious animals, particularly mosquitoes, sandflies and midges, some of which act as vectors of disease. There can be a tremendous diversity and abundance of these insects: some 84 mosquito, 13 sandfly and 21 horsefly species are reported from the freshwater Nariva Swamp, Trinidad (Bacon *et al.*, 1979), while 183,000 individual mosquitoes of a single species were caught in a light trap one night in a Cayman Islands mangrove swamp (Brunt and Davies, 1994). However, their nuisance potential must not be allowed to serve as an excuse to destroy their important role as links in aquatic, and to a lesser extent terrestrial food webs, particularly their larvae which are eaten by commercially important fish.

Links Between Wetlands and Other Habitats

In addition to direct economic values, through the provision of a range of goods and services, wetlands are of great indirect value through linkages with associated aquatic ecosystems. As indicated above, many species use wetlands for nursery purposes. In addition, the transfer of organic matter and biota by downstream flow or tidal export influences nutrient status and food webs outside the wetland itself. In Australia, Banana Prawns *Penaeus merguiensis* require mangrove-lined estuaries if they are to complete their life cycles (Robertson and Duke, 1987); in Colombia, the Cienaga Grande lagoon is thought to be responsible for rearing 70% of the fish harvested on the Caribbean coast (Bossi and Cintron, 1990); the organic matter and nursery environment of the Laguna de Terminos, Mexico, support a coastal fishery producing annually 15,000 tonnes of shrimp, 13,000 tonnes of shellfish and 122,000 tonnes of fish (Yañez-Arancibia *et al.*, 1992). Mention has been made above of migratory waterfowl utilization of wetlands as staging posts, an example of a

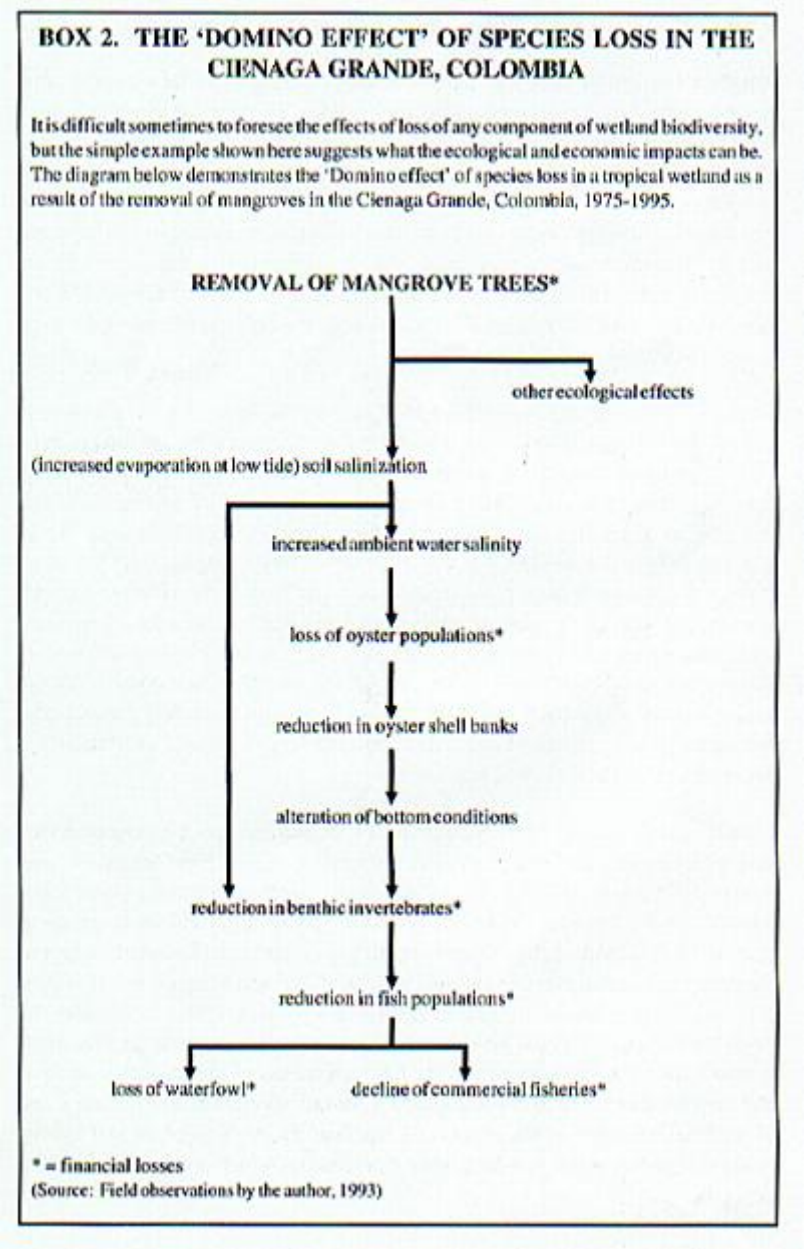
wetland in one country supporting the biodiversity and commercial harvest of resources in another, often in a different biome in a distant country. In Jamaica, the close association between mangroves and coral reefs, in terms of exchanges of nutrients and biota between the two wetland types, suggests that the presence of mangroves greatly influences the health and productivity of the reefs which are the mainstay of the artisanal fishing industry.

The Consequences of Loss of Wetland Biodiversity

It is obvious from the large number of resource organisms mentioned earlier, that loss of wetland species has economic implications. The livelihood and culture of large numbers of people, in almost every country of the world, will be endangered if wetland resources become further depleted. A major portion of fisheries production, most hunting, much forest production and a significant part of ecotourism will be lost worldwide, as well as elements of heritage and environmental quality. It is important to stress, however, that it is not sufficient just to protect the populations of plants and animals that are directly exploited: their health and survival, or sustainability, depend on maintaining the whole complex of biodiversity that characterizes wetland ecosystems.

Commercially exploitable wetland plant and animal species will be available only if the biological processes which produce them are maintained. These include primary production, nutrient cycling, pollination, flowering, fruiting, decomposition, food web interactions, grazing, predation, immigration and emigration, to name a few. Hundreds of inter-related organisms take part in this gamut of processes and it is this diversity of wetland species which keeps these ecosystems in ecological equilibrium and makes them so productive. Loss of any link in the web of biodiversity will reduce the goods, functions and attributes of a wetland site (see Box 2). Decline in a wetland will impact on associated systems: loss of nursery habitat could reduce coastal fishery yields or loss of a wetland on a flyway could disrupt waterfowl migrations, threatening the capacity of individual birds to reproduce and eventually the survival of populations or species.

Finally, the real biodiversity of nature lies at the level of the genotype (the hereditary or genetic make-up). The variability, geographic dispersion and biological richness of wetlands globally mean that they contain a tremendous pool of genetic resources. This genetic diversity is important for a variety of reasons: it determines the ability of individuals and populations to adapt to changing environmental conditions, such as global warming or new diseases; it is essential for the continuing evolution of various species; it provides the basis for the selection and production of new resource organisms. Finally, it is also important for maintaining the distinctiveness of plants and animals in different locations which has implications for our appreciation of nature. Loss of wetland habitats, which contain so much of the world's plant and animal biodiversity, thus endangers the genetic resources on which our future prosperity depends.



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CHAPTER 2

THE RAMSAR CONVENTION:

Its role in conservation and wise use of wetland biodiversity

By Michael Smart, Senior Policy Advisor, Ramsar Bureau, Switzerland

Intergovernmental Conventions on the Environment

The last 25 years have seen a growing consciousness, among the general public and at the highest political level, of the importance of environmental issues. The initial motive was a concern, often articulated in the first instance by individuals in the richer countries, for nature conservation issues, a recognition that certain plants and animals, formerly common, were decreasing or disappearing. This has evolved in the last few years, with increasing input from developing countries - where many people depend for their livelihood on the productivity and the biodiversity of their environment - into the realization, most memorably expressed at the 1992 Earth Summit in Rio de Janeiro, that a

healthy environment is important not only for birds, bees and flowers, but also for human well-being, in short that a healthy environment is an essential part of socio-economic development.

As a result of the pioneering action of these individuals, non-governmental organizations (NGOs) took up the environmental cause, and pressed governments for action. Governments then drew up legally binding conventions or treaties on environmental matters by which member states (or Contracting Parties) agree to take action in a specific environmental field. Thus the 1970s saw the creation of a number of conventions, the Ramsar Convention on Wetlands being the first in 1971. The input of NGOs has always been essential in the development and implementation of international conventions and, in Ramsar's case, the role of BirdLife International (formerly ICBP), IUCN - the World Conservation Union, Wetlands International (formerly the Asian Wetland Bureau; the International Waterfowl and Wetlands Research Bureau; and Wetlands for the Americas) and the World Wide Fund for Nature (WWF) has been crucial. In the last few years, the second generation of international legal instruments has come into being. These newer conventions, building on the pioneer work of their predecessors, take a more holistic view of environmental issues. In an era convinced of the importance of market forces, they have mechanisms for financial support.

The opening chapter of this volume has presented the diversity and productivity of wetlands. The present chapter demonstrates how the Ramsar Convention or Convention on Wetlands contributes to conservation and wise use of wetland biodiversity, the direction Ramsar plans to take in the future and Ramsar's links with other environmental conventions, in particular the Convention on Biological Diversity (CBD).

Ramsar - the Convention on Wetlands

Introduction: The Convention on Wetlands of International Importance especially as Waterfowl Habitat was adopted at Ramsar, a city on the Iranian shores of the Caspian in 1971. The Convention was astonishingly far-sighted for its time, recognizing several important principles which are now widely accepted: the interdependence of Man and his environment; the fundamental ecological functions of wetlands as regulators of water regimes; and the value of wetlands in economic, cultural, scientific, and recreational terms. This concern with the functioning of wetlands, and how it affects mankind and his cultural and economic well-being, has become more and more relevant over the first 25 years of Ramsar and will undoubtedly be a major issue for the 21st century, when water supply will become even more crucial.

Although the Convention's original focus was on wetlands as a habitat for waterfowl, Ramsar has developed into an international instrument dealing with wetlands from a broader point of view. Ramsar remains the only international convention that concentrates on a particular type of

ecosystem - wetlands - rather than on species or other issues. Such an approach is natural, given the widely held view that wetlands and forests are two of the most threatened ecosystems in world terms.

Ramsar establishes, for the first time in an international convention, two basic concepts:

- The *List of Wetlands of International Importance*: a list of important sites proposed by member governments, who formally accept an obligation to maintain the ecological character of these sites.

- The principle of *wise use* of all the wetlands in the territory of a Contracting Party. Wise use of wetlands is considered as synonymous with sustainable use, a term which has recently gained general currency.

Like any other convention, Ramsar is a living, evolving instrument. The emphasis in the early years was on listed sites, the flagship concept which attracted immediate attention and publicity. In recent years, the broader concept of wise use has become increasingly important, with the growing realization that listed sites cannot be conserved in a vacuum but are affected by decisions taken outside their boundaries; the crucial need is to integrate conservation and wise use of wetlands into national land use and water management strategies. While the Ramsar text sets out basic concepts, guidance is needed on how to put them into practice and how to adapt them to changing world perceptions. In its first 25 years, Ramsar member states have, at their Conference of the Parties (normally held every three years), approved numerous interpretations of the text and mechanisms to make sure that the basic concepts of the Convention are effectively applied.

Definition of wetlands: An important feature of Ramsar is its approach to the once unfamiliar term 'wetlands'. The definition of wetlands in the first article of the Convention, one of the broadest possible, has been widely accepted:

> 'Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.'

This definition encompasses coastal and shallow marine areas (including coral reefs), as well as river courses and temporary lakes or depressions in semi-arid zones.

Benefits and values of wetlands: The Ramsar 'Guidelines on wise use' provide a succinct account, for both decision-makers and the general public, of the benefits and values of wetlands

which may be felt within the wetland itself or some way away from it (for example in the case of wetlands which absorb floods). The Guidelines summarize the benefits as follows:

- sediment and erosion control;
- flood control;
- maintenance of water quality and abatement of pollution;
- maintenance of surface and underground water supply;
- support for fisheries, grazing and agriculture;
- outdoor recreation and education for human society;
- provision of habitat for wildlife, especially waterfowl;
- contribution to climatic stability.

If the natural functions of wetlands are maintained, these benefits will accrue to human populations free of charge. Destruction of wetlands means either that these functions have to be provided artificially at considerable cost, or that the wetland has to be restored, which costs even more.

Listed sites: The best-known obligation of Ramsar member states is to include at least one wetland from their territory (which may be state or privately owned areas) in the *List of Wetlands of International Importance.* Wetlands on the List are often called 'Ramsar sites', an expression frequently used in this book. This is the traditional protected areas approach to conservation, elevated to an international level. Such sites are not merely a national park or reserve; governments accept an undertaking before the world community to maintain the ecological character of Ramsar sites thus making a direct contribution to the conservation of wetland biodiversity. As of 12 July 1996, the 93 Contracting Parties had designated 838 wetlands for the Ramsar List, covering an area of some 540,000km2, i.e. roughly the size of France or Kenya. **[As of September 2004: 141 Parties and 1375 sites]**

The Convention has established a number of measures to guide member states in carrying out this obligation to list and conserve wetlands of international importance. Among them are:

- The *Criteria for Identifying Wetlands of International Importance*, which identify sites that could be included in the List; actual designation for the Ramsar List remains the prerogative of each Contracting Party concerned. The various categories of criteria, which have been developed over the years and are still evolving, cover: representative or unique wetland ecosystems; wetlands of value because of the diversity of their plant or animal life or because they support threatened or endemic species; and wetlands which are of particular value for waterfowl (high numbers of a range of species or 1% of the total numbers of one species, sub-species or population), or for fish.

These criteria have been used by Ramsar's NGO partner organizations to compile regional directories of potential Ramsar sites for Africa, Asia, Europe, the Middle East, Oceania, South and Central America and the Caribbean, and a regional inventory is in preparation for the Commonwealth of Independent States. Meanwhile many Contracting Parties (e.g. Australia, France, Italy) have used the criteria to draw up their own national scientific wetland inventories.

- A simple, worldwide *Classification System for Wetland Types* which identifies 35 kinds of wetlands, together with a wetland datasheet, so that all the world's Ramsar sites can be classified and described in a standard fashion. These descriptions are stored in the Ramsar Database, which can be used to analyse widely differing wetlands across the world, and as a basis for advice to wetland managers, drawing on experience at comparable sites in other corners of the world.

- The *Montreux Record*, which identifies Ramsar sites whose biodiversity is under particular pressure in the face of technological developments, pollution or other human interference. Inclusion on the Record is effected by member states, in consultation with the Ramsar Bureau (or secretariat), and highlights sites where urgent action is needed, possibly with the help of other member states. As of 12 July 1996, the Montreux Record included 65 Ramsar sites, an indication of the difficulty of maintaining the ecological character of wetlands. One UK site, on the Scottish island of Islay, was included on the Montreux Record because proposed reclamation and road building could have led to destruction of a considerable portion of the site; after extensive discussion and study, the plans were cancelled, and the site was removed from the Record. The Djoudj National Bird Park, a Ramsar site in Senegal noted for its high numbers and diversity of waterbirds, was included in the Montreux Record because of fears that water inflow would be restricted; the site was removed from the Record after arrangements had been made to guarantee quantity of water supply, but has since been reinserted because the quality of the water changed and the very fresh water has led to clogging of the wetland with floating weeds.

- The *Management Guidance Procedure* (formerly known as the Monitoring Procedure) which enables the Ramsar Bureau to organize missions to visit Ramsar sites (particularly those on the Montreux Record) and to offer advice. The Procedure has been operated at more than 30 Ramsar sites and a number of notable successes in conservation of wetland biodiversity have been achieved: at the Nariva Swamp in Trinidad & Tobago, conflicts over use of parts of the area for agricultural production have been resolved, and a general management plan involving local communities is being carried out; in the March/Thaya valley in Austria, a plan for the wise use of the whole area has been approved and implemented; in South Africa, the Ramsar monitoring mission to St Lucia contributed to the

national investigation into the effects of dune mining, which resulted in a government decision not to allow mining of rare metals in the Ramsar site, an activity which would have had a direct effect on the diversity of the flora and fauna.

Wise use of wetlands: In addition to its involvement in listed sites, Ramsar from the outset adopted the concept of wise use of wetlands. Ramsar defines this concept as follows:

> 'The wise use of wetlands is their sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem'.

Essentially, the wise use concept means that the natural productivity and biodiversity at a site can be utilized as long as the basic ecological functioning of the wetland is not disturbed. A fine example of the wise use of a wetland is the Sundarbans, a mangrove forest shared by India and Bangladesh, part of which has been designated as a Ramsar site. Many thousands of local people exploit the natural productivity of this wetland, harvesting mangrove trees, palm leaves, fish and other natural resources, yet the Sundarbans remains one of the richest wildlife areas in the world. Another example is the Wadden Sea, Europe's biggest estuary, which is located in a densely populated area and shared by Denmark, Germany and the Netherlands. The entire estuary is a Ramsar site and the three states have developed a joint management concept, based on wise use; it aims at controlling hunting, oil exploration, fisheries (especially shellfish) and tourism, and reconciling them with nature conservation.

The Angélique Creek in the coastal marshes of Les Marais de Kaw, a Ramsar site in French Guiana. This wetland meets several of the Criteria for Identifying Wetlands of International Importance being noted for its population of globally threatened Black Caiman, for the several hundred thousand migratory waterbirds which nest in North America and occur here during migration and wintering periods, and also for its populations of nesting herons, spoonbills, and ibises.*(Photo: Olivier Tostain)*

The wise use concept does not, however, relate only to actions at site level. The Convention has approved *Guidelines on Implementation of the Wise Use Concept* and *Additional Guidance on Wise Use* which encourage Ramsar members to adopt

National Wetland Policies, thus recognizing the need for broad policy work on wetlands at the highest decision-making level. The adoption of National Wetland Policies demands a thorough review of a state's legislation, institutions and practices relating to wetlands and, although rather few states have adopted such policies at the present time, positive steps towards this goal are in evidence: Canada has adopted a Federal Wetland Policy, Uganda has recently adopted its national policy, while other states, notably Australia, Costa Rica, Trinidad & Tobago and several states of Africa and the Mediterranean, reported on their progress towards a National Wetland Policy at the Brisbane Conference in March 1996.

Finance for wetland work: Over the years Ramsar has generated funds for wetland conservation and wise use projects in developing countries and states whose economy is in transition. Such funds have been raised in two ways: by channelling bilateral assistance through the Ramsar Bureau, for example, the preparation of management plans for the Ramsar sites of Paracas in Peru and Caño Negro in Costa Rica, funded by the USA, or the development of a national wetland plan in Bulgaria, funded by France; and via the Small Grants Fund (formerly the Convention's Wetland Conservation Fund) which has supported 10 to 12 projects every year since 1991, each costing a maximum of 40,000 Swiss francs. Projects financed by the fund have included an inventory of Tunisian wetlands, training activities in Kenya and India, and management of listed wetlands in Brazil, Honduras, Indonesia, and Niger.

A stand of Nipah Palms lines a riverbank in the Sundarbans. The leaves of this palm are used for thatching and are sustainably harvested here. *(Photo: Zakir Hussain)*

Ramsar - Future Directions

A mission statement for the Convention was adopted at Brisbane, thus providing a focus for the activities of the Convention from 1997-2002. It states that:

‘The Convention's mission is the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world'.

A number of objectives and actions have been identified to help Ramsar achieve its mission in this period and some of the most important are highlighted below:

- The Convention can only be fully effective if as many states as possible become Contracting Parties, so there will be a strong drive to recruit new Ramsar members, particularly in under-represented regions such as the Caribbean, the Near East, Southern Africa and the Pacific, with a goal of 120 members by 2002.

- Since National Wetland Policies are fundamental to the aim of achieving wise use, emphasis will be placed on establishment of a larger number of National Wetland Policies.

- Implementation of the Convention will focus on the role of wetlands in the context of land-use planning (especially in coastal zone planning and river basin management). Special attention will be given to the relationship between wetlands and water resource management. For many developing countries, water will be one of the scarcest and most valuable resources in the 21st century, yet wetland conservation and water supply, which are very closely related subjects, are often treated as totally unrelated sectors.

- More precise ways of calculating the real economic values of wetland functions will be provided, greater attention will be paid to wetland restoration and rehabilitation, to empowerment of local communities in wetland management and to involvement of the private sector in wetland issues.

- Another major task will be to build on the work of regional wetland inventories and individual wetland scientists, to provide a better overall definition of global wetland resources and hence the scope of the Convention's work: how much wetland is there in the world? how many Ramsar sites could and should there be? how much work is needed for management and restoration of wetlands?

- As for Ramsar sites, attention will be paid both to quantity and quality. The aim is to reach 1,000 Ramsar sites by the year 2002, and to ensure that they are properly managed (50% should have management plans by then), and that their ecological character is maintained and monitored. In future greater emphasis will be placed on designating sites from certain wetland types hitherto given insufficient attention, notably peatlands, mangroves, seagrass beds and coral reefs.

- Greater public support for wetland conservation and wise use will be sought by more intensive efforts to raise awareness of wetland values and functions. A natural corollary of this approach will be to reinforce the capacity of institutions, especially in developing countries, through training programmes, and to ensure that development agencies, both multilateral and bilateral, take account of wetland values, a part of the task of raising awareness.

- Ramsar receives many demands for funding of projects on conservation and wise use and an attempt will be made to increase the resources available to the Small Grants Fund to a million dollars a year. In addition, the Bureau will act as a catalyst, identifying funding sources for projects on conservation and wise use of wetlands, whether with bilateral or multilateral funding agencies, private sector sources, foundations or NGO bodies.

Ramsar and Other Environmental Conventions

In its first 25 years, Ramsar has made a considerable contribution to the conservation and wise use of biological diversity in wetlands. The role played so far has been largely in terms of promoting awareness of wetlands and providing technical support for governments. The fact that the word wetland has gained such currency is an indication of success in awareness campaigns. The designation of over 800 wetlands, covering 540,000km2 worldwide, for the Ramsar List, and the increasing efforts to conserve their ecological character, are other positive signs. The growing recognition of the importance of wetlands, in terms both of productivity and biological diversity, is shown by the interest in wetlands of organizations such as the Organization for Economic Development (OECD), and by the growing number of states which integrate wetlands into national policy-making through National Wetland Policies.

With the increasing number of environmental conventions now in existence, the watchwords must be partnership and coordination. Links of course already exist between Ramsar and other international environmental conventions. Some famed wetlands - Everglades in USA, Doñana in Spain, Keoladeo (Bharatpur) in India, Banc d'Arguin in Mauritania, Ichkeul in Tunisia - figure on the lists of both Ramsar and the 1972 World Heritage Convention. The 1975 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), deals with trade in a number of wetland species, and so has strong links with Ramsar. There is obvious potential for cooperation between Ramsar (which is concerned with the habitats of species linked to wetlands and particularly waterfowl) and the 1979 Bonn Convention on Migratory Species (which is concerned with the migratory species themselves). The recent adoption, under Bonn, of the 'Agreement on the Conservation of African-Eurasian Migratory Waterbirds' opens the door for even broader cooperation, and there are prospects of similar agreements in other regions; thus the

Ramsar Conference in Brisbane in March 1996, adopted the 'Brisbane Initiative' on the establishment of a network of listed sites along the East Asian-Australian flyway.

Labrador Tea *Ledum palustre*, a shrub found within the *Sphagnum* dominated peat bog ecosystem at Kushiro Marsh. Ramsar will be placing more emphasis on the designation of peatlands as Ramsar sites in the future. *(Photo: Hisashi Shinsho)*

Nor are the opportunities to work with regional conventions overlooked: Ramsar cooperates with the Berne Convention on European Wildlife and Natural Habitats, with the European Commission's many initiatives for conservation of wetlands, and with the UNEP Regional Seas Conventions, notably in the Mediterranean and Caribbean. Thus in the Mediterranean, the European Commission provided much of the funding for the first phase of the 'MedWet' initiative, an innovative partnership between five European Union member governments, the Ramsar Bureau and a group of international and national NGOs, which drew up Mediterranean methodologies for conservation and wise use of Mediterranean wetlands; the second phase of MedWet is applying these methodologies in non-EU states of the Mediterranean, whilst a third phase will seek larger funding from Global Environment Facility (GEF) sources; meanwhile, at the Mediterranean Wetlands Conference in Venice in June 1996, a Mediterranean Wetland Strategy was endorsed, and Ramsar and the MedWet partners are collaborating with the Barcelona Convention in its implementation.

As previously noted, the newer conventions such as the Montreal Protocol on substances that deplete the ozone layer, or the Conventions on Biological Diversity, Climate Change and Combating Desertification adopt a holistic approach to conservation of biological diversity. Furthermore, the Montreal Protocol has its own funding mechanism, while the GEF acts as a funding mechanism for CBD and Climate Change.

GEF has recently adopted an Operational Strategy covering its four focal issues (biodiversity, climate change, ozone layer depletion, and international waters), all of which have relevance to wetlands. Changes in the world's climate, the province of the Framework Convention on Climate Change, also have major implications for wetlands: changes in weather patterns could mean that existing wetlands decline, to be replaced by new ones in other sites. Sea level rise is another general phenomenon with a potential to bring severe changes to wetlands in coastal areas, and one which marine states (and particularly small island developing states) take very seriously. Similarly, international waters - wetlands such as the courses of major rivers or coastal zones which in ecological terms are part of the same unit - may belong in political terms to different states; hence

the need for coordination and consultation between the states concerned, as provided by GEF's focal issue on international waters, and in Ramsar's article on shared water systems. The work of the Convention to Combat Desertification could be seen as Ramsar in reverse: one convention concentrates on conserving wetlands, especially in arid zones, while the other seeks to prevent the encroachment of the desert.

Of particular relevance to the Ramsar Convention is the CBD which acts very much as an overarching structure, to which other conventions, with their own more precise focus, can and must relate and contribute. The CBD defines biological diversity as:

> 'The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'.

The CBD's broad formulations include articles on conserving biodiversity and on using biodiversity in a way that guarantees its survival (i.e. sustainable use of biodiversity). Many specific points of common concern between Ramsar and the CBD can be highlighted (see Box 3). Collaboration between the two conventions could promote overviews of the world's biodiversity; hitherto Ramsar's work has tended to reflect national concerns (hence the tendency for examples in the present volume to illustrate wetland values at national level as a contribution to the conservation of global wetland species and habitat diversity). There is still a need for prioritization at world level of wetland conservation tasks, and work of this type by Ramsar could act as a prototype for identifying world wetland priorities as a guide for other biomes.

BOX 3: COMMON CONCERNS OF RAMSAR AND THE CBD

National Policy Issues

- Ramsar's Article 3.1 states that Contracting Parties shall formulate and implement their planning so as to promote the wise use of wetlands in their territory. This has been interpreted by the Conference to mean development of National Wetland Policies which, with their cross-sectoral nature, contribute to National Biodiversity Strategies.

- CBD Article 6 on 'General measures for conservation and sustainable use' speaks of national strategies, plans or programmes for the conservation and sustainable use of biodiversity. National Biodiversity Strategies clearly include wetlands.

Identification and Monitoring

- Ramsar has promoted regional and national inventories of wetland biodiversity; it has developed guidelines on monitoring change of ecological character in wetlands; it has developed standard recording techniques for wetlands and established a database of Ramsar sites.

- CBD's Article 7 on 'Identification and Monitoring' calls for identification and monitoring of components of biological diversity, for identifying of processes or categories of activities which have adverse impacts on biological diversity, and for maintaining data derived from the preceding activities.

In-Situ Conservation

- Ramsar's Article 2.1 says that Contracting Parties shall designate suitable wetlands for the Ramsar List. Wetlands sites designated for the Ramsar List, together with other wetlands meeting the Ramsar criteria, provide the basis for conservation of biological diversity in wetlands.

- CBD's Article 8 speaks of establishment of a system of protected areas or areas where special measures need to be taken to conserve biological diversity. It gives details of measures to be taken for the conservation of such areas.

Sustainable Use of Components of Biological Diversity

- The wise use concept established in Article 3.1 of Ramsar extends to all wetlands in the territory of a Contracting Party. Empowerment of local communities and increased involvement of the private sector are priorities in the Strategic Plan 1997-2002.

- CBD's Article 10 on this topic speaks of integrating consideration of the conservation and sustainable use of biological resources into national decision-making, of support for local populations, and of encouraging cooperation between governmental authorities and the private sector.

Research and Training

- Ramsar 's Article 4.5 calls for the training of personnel competent in the fields of wetland research, management and wardening. The MedWet initiative on Mediterranean wetlands, in which Ramsar has been closely involved, has acquired considerable experience in training

applied to Mediterranean wetlands, and these results could be used in other regions. Likewise, the 'Wetlands for the Future' programme, promotes wetland training initiatives in the Neotropics, with US funding. The Ramsar Strategic Plan identifies capacity building through training as an activity of the highest priority for 1997-2002. Ramsar's Scientific and Technical Review Panel acts in an advisory capacity on wetland issues to the Convention.

- CBD's Article 12, which refers to the special needs of developing countries, calls for research and training courses. It also refers to the work of the Subsidiary Body on Technical, Technological and Scientific Advice.

Public Education and Awareness

- The Ramsar Strategic Plan for 1997-2002 gives the highest priority to education and public awareness. Again, the MedWet initiative on Mediterranean wetlands has acquired considerable experience in this field in Mediterranean wetlands, and these results could be used in other regions.

- CBD's Article 13 calls on Contracting Parties to promote understanding of the measures required for conservation of biological diversity and for cooperation between states on this topic.

The same governments are Contracting Parties to both conventions, and best use of ever scarcer resources demand that the two conventions strengthen their cooperation. In recognition of this the secretariats of the two conventions signed a Memorandum of Cooperation in early 1996. This Memorandum provides for:

- institutional cooperation (participation in one another'smeetings);
- exchange of information and experience (especially between databases);
- coordination of work programmes (work plans, and reporting requirements to the Conference of the Parties);
- joint conservation action (integration of national biodiversity plans and national wetland strategies; effective conservation and sustainable use of biodiversity in wetlands; consistent methods of monitoring sites; coordination of research, training and public awareness).

The two conventions must now march forward to meet the challenge, building on the instructions of their respective Conferences of the Contracting Parties and on the Memorandum of Cooperation signed by the two secretariats.

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CHAPTER 3

THE AFRICAN REGION

An Overview of African Wetlands

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Introduction

The African region as described in this overview includes the mainland continent and the island states of Cape Verde, Comoros, Madagascar, Mauritius, Sao Tome & Principe, and Seychelles, making up a total of 53 States, 23 of which are Contracting Parties to the Ramsar Convention. Africa's size and diversity of landscape are striking: bordered by the Mediterranean Sea to the north, the Indian and Atlantic oceans to the east and west respectively, and the Antarctic in the south, it covers 70º of latitude, several climatic zones, and a considerable altitudinal range.

Various wetland types characterize the diverse and panoramic African environment, from mountains reaching an altitude of 6,000m through deserts to coastal zones at sea level. Although wetlands constitute only around 1% of Africa's total surface area, (excluding coral reefs and some of the smaller seasonal wetlands), and relatively little scientific investigation has been undertaken in them in comparison to other ecosystems such as forest or to wetlands in other parts of the world, their important role in support of the region's biodiversity and the livelihood of large human populations is becoming increasingly clear from ongoing studies.

General Distribution and Diversity of Wetland Types

The greatest concentration of wetlands occurs roughly between 15°N and 20°S and includes some rather spectacular areas: wetlands of the four major riverine systems (Nile, Niger, Zaire and Zambezi); Lake Chad, and wetlands of the Inner Niger Delta in Mali; the Rift valley lakes (notably Victoria, Tanganyika, Nyasa, Turkana, Mweru and Albert); the Sudd in southern Sudan and Ethiopia; and the Okavango Delta in Botswana, all of which display a richness and uniqueness in biodiversity.

Other important wetland types are found on the saline and brackish coastal and marine areas along the African coastline. They include the mangrove forests of eastern Africa stretching from the coastal cities of Kisimayu in Somalia to Maputo in Mozambique, and in broken but rich stands along the west African coastline from northern Angola to their northern limit north of Tidra Island in Mauritania, covering a total area of approximately 1.7 million hectares. Coral reefs and associated seagrass beds are found along the same limits as mangroves, although principally located along the warm Indian Ocean coastline and rarely in the Atlantic Ocean. Added to the list are coastal pans/lagoons and marshes such as the Ebrié and Tadio lagoon complexes of C'te d'Ivoire.

A few significant wetlands are located outside the 15°N to 20°S area. These include the inland oases, wadis and chotts of northwest Africa, the Oualidia and Sidi Moussa lagoons in Morocco, the Limpopo River floodplain in southern Africa, the Banc d'Arguin of Mauritania, and the St. Lucia wetlands in South Africa which is one of the largest estuarine systems in the African continent.

From the freshwater forests to the saline lakes and massive floodplains, Africa's many wetland types support a great diversity of plants and animals, and their productivity provides the natural resources essential to the survival of a significant part of the African rural population.

Biodiversity in African Wetlands

The biological diversity of wetlands in the continent is unevenly distributed, with some habitats being characterized by a richer range of species than others. In particular, wetlands in areas of high rainfall and warm climates, such as the Congo Basin, display a richer species diversity than those of drier regions north and south of the 15ºN to 20ºS zone. Of course, the importance of any given wetland from a biodiversity perspective is assessed not only by the overall richness in number of species present, but on the uniqueness of the area in terms of the number of localized species, particularly the endemic species. In this regard, most African wetlands display both characteristics, richness in number of species and endemism. There are, for example, over 2,000 known species of indigenous freshwater fishes in Africa. The Zaire River Basin, probably the most diverse area in Africa for its fishes, has over 700 identified species of which 560 are endemic to the basin. There

are at least 18 families of endemic freshwater fish fauna many of which are found in the great lakes of east and central Africa.

It is believed by some authorities that wetland areas of highest endemism and of international significance in Africa are the Inner Niger Delta in Mali, the seasonally inundated floodplain of northern Central African Republic and southern Chad, the Sudd region of southern Sudan, Lake Victoria and Kyoga in Uganda, the swamps of western Tanzania and various parts of Zambia, and the Okavango region of northern Botswana.

In southern Africa, the role of wetlands in supporting a wide range of biodiversity is similarly recognized. In the Bangweulu Basin, Zambia, are important populations of the threatened Black Lechwe *Kobus leche smithemani* (IUCN Red List, 1994) and Shoebill Stork*Balaeniceps rex* (the latter also found in Lake George, Uganda, Case Study 5). The St. Lucia System of wetlands of South Africa, described in Case Study 3, exemplifies biodiversity rich estuarine wetlands in Africa and boasts great diversity of plant life in its freshwater reed and papyrus swamps, freshwater swamp forest, tidal swamp forest, grasslands, mangroves and riverine woodlands. This plant diversity helps to support over 350 bird species, more than 180 species of estuarine fish and 38 freshwater fish as well as significant populations of hippopotamus and crocodile.

The Sahel wetlands of western Africa are concentrated mainly in the Senegal River Basin in Senegal and Mauritania, the Niger River Basin in Mali, and Lake Chad and the Logone and Chari rivers in Cameroon, Nigeria and Chad. Because of their abundant food source and attractive habitats, they host numerous endemic and migratory waterfowl. The floodplains of the Senegal, Niger and Chad basins for example, support over a million waterfowl while the Djoudj National Bird Park, Senegal, (Case Study 2), and Diawling National Park, Mauritania, are havens for migratory birds in west Africa, providing habitat for over three million birds belonging to nearly 400 species.

The Sebkhet el Kelbia of Tunisia (Case Study 4) represents the unique shallow depressions in the arid and semi-arid parts of North Africa. These are characterized in wet years by a high primary productivity and a diversity of habitats and natural resources which enables them to support a large number and diversity of migratory, wintering and nesting birds. These wetlands exhibit dramatic seasonal cycles, changing from wet to dry seasons which enables them to support a succession of aquatic flora and fauna.

The Values of African Wetlands

It has been argued that African wetlands include some of the most productive ecosystems in the world and indeed they are an important, and in many cases the exclusive, source of natural resources upon which rural economies depend, providing food and energy, medicine, building

material, dry season grazing and transportation for large human populations. In the Inner Delta of the Niger River over 550,000 people with about a million sheep and a million goats use the floodplains for post-flood dry season grazing. There are many more examples of how local communities make use of the diversity and high productivity of wetlands (for example, see Box 4).

Box 4: Examples of the Many Uses of the Biodiversity and Productivity of African Wetlands by Local Communities

In Uganda people harvest *Cyperus papyrus* to make mats and baskets.
In Rwanda *Cyperus papyrus* is compressed into fuel briquettes with a high calorific content.
In the Okavango Delta roots, palm *Hyphae*, *Phragmites*, and palm hearts are harvested for subsistence foods, wine and in southern Africa, the vegetation is rich and diverse, and water lily tubers, bulrush building material.
In the Inner Niger Delta rice, millet, maize and wheat are cultivated in the highly productive soils of wetland areas.
Over 600 local people are employed in tourist camps in the Okavango Delta.

It is not only people who benefit from the high plant productivity in wetlands. In the Kafue Flats of Zambia, the local herdsmen graze their cattle on 40% of the highly productive*Vossia/Echinochloa* vegetation, while the endemic Kafue Lechwe *Kobusleche kafuensis*grazes more than 80% of the *Paspalidium* water meadow. Indirectly, the heavy dependence of large mammals on wetlands in Africa is of immense economic value to African countries since they are the mainstay of the tourist industry. These animals include elephants, buffaloes, antelopes, crocodiles, hippos, and zebras and the major predators, lions, wild dogs and hyenas. The lives of Africa's large mammals are often inextricably linked to wetlands. For example, the Amboseli swamps in Kenya are the only water source for animals in the surrounding area. Equally, the rich, riverine vegetation of the Masai Mara Game Reserve supports antelope and other mammals during the dry season.

Threats to Wetland Biodiversity and Future Prospects

Africa still has a significant number of pristine wetlands when compared to Europe or parts of North America. However, some wetland areas are experiencing immense pressure from human activities, the most important being drainage for agriculture and settlement, excessive exploitation by local communities and improperly planned development activities. In spite of the noted importance of wetlands to local communities, the human pressure on wetlands is expected to increase as populations grow, unless strategic actions are put in place for the conservation of wetlands.

The case study on Djoudj National Bird Park, for example, records the construction of dikes and dams on the upper parts of the Senegal River for the development of rice cultivation. This has

altered the freshwater regime, threatening the survival of some plant species and encouraging the spread of others - essentially altering the characteristics of the ecosystem. Equally, the damming of the Tana and Athi rivers in Kenya has blocked upstream movement of migratory fish species, while poor water management schemes in the north of Cameroon have reduced natural flooding in Waza National Park, thus contributing to the decrease in the populations of two species of antelope, the Korrigum *Damaliscus lunatus korrigum* and Buffon's Kob *Kobus kob kob*.

Other threats to African wetlands include changes in wetland water quality due to the effects of industrial effluent and agricultural pesticides, siltation from highland catchment areas, and introduction of alien species of flora and fauna leading to colonization by single species and loss of endemic species diversity. Perhaps one of the biggest single catastrophes has been the introduction of the Nile Perch *Lates niloticus* and a species of tilapia *Oreochromis niloticus* to Lake Victoria which has led to the extinction of a large number of the 200 or so endemic cichlids of the lake; a tragic loss of biodiversity. Similarly, the introduction to the same lake of alien plant species, the Water Hyacinth, *Eichhornia crassipes* and Water Lettuce *Pistia stratiotes*, threatens the existence of endemic flora.

The threat to African wetlands has global effects on the world's biodiversity. The future of African wetlands lies in a stronger political will to protect them, based on sound wetland policies and encouragement for community participation in their management. Although the goal for protected wetlands should continue to be conservation of endangered and fragile sites, greater efforts should be focused on wetlands outside protected areas, and new management strategies formulated which incorporate the stakeholders. The Government of Uganda has recently launched such a policy for the conservation of its wetland resources. This is the first of its kind in Africa to have been formulated in accordance with the recommendation from the Ramsar Convention. It encompasses wetlands in protected and non-protected areas and offers the best example in Africa of a strong political will to conserve wetlands and their biodiversity. It is important that African countries put such policies in place, and other management strategies such as Integrated Coastal Zone Planning, an important measure for safeguarding coastal wetlands. Such a plan is being carried out in Guinea Bissau at the present time with the assistance of the World Conservation Union (IUCN).

Following the framework provided by the Ramsar Convention for supporting conservation and wise use of wetlands, more African states are joining the Convention and designating additional sites for inclusion in the List of Wetlands of International Importance. Other non-members are adopting the Convention's approaches to wetland conservation (especially as regards development of wetland policy instruments) and taking the necessary steps leading to membership. The growth of the Convention in Africa is an indication of commitment to the conservation and wise use of wetlands and their biodiversity.

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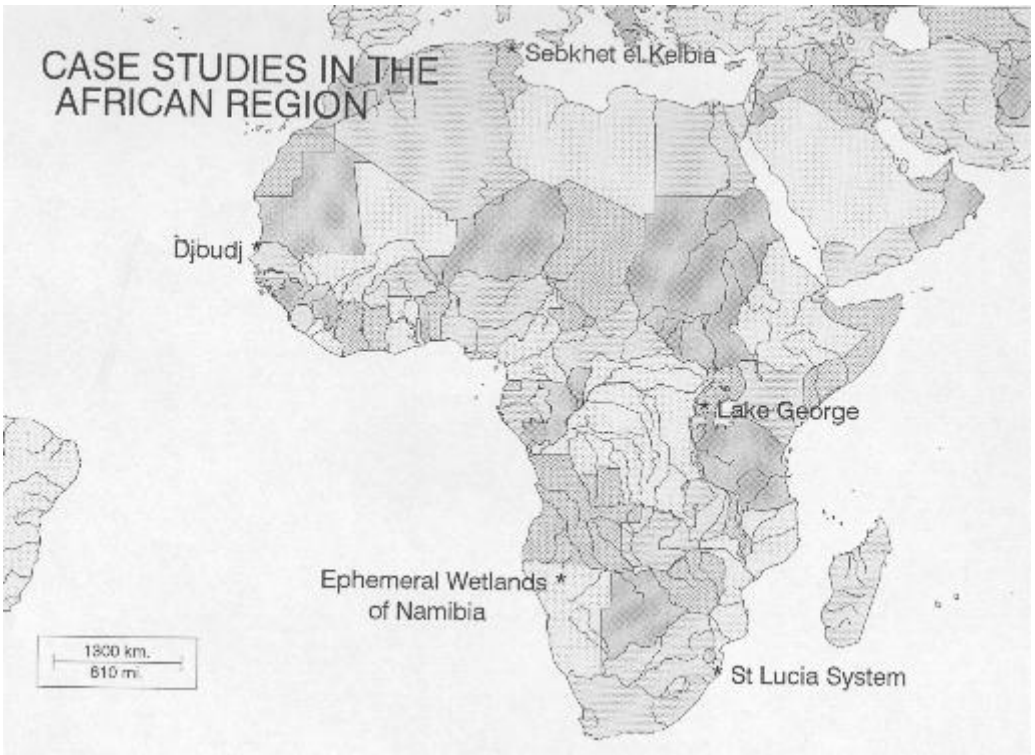

Case Study 1: Namibia

The Ephemeral Wetlands of Central Northern Namibia

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Major Features of the Wetlands

The ephemeral wetland system of central northern Namibia consists of the Etosha Pan, Lake Oponono and the Cuvelai inland delta/drainage. This is by far the largest wetland system in Namibia, covering some 30,000km2.

The area can be subdivided into several distinct habitats, each with its distinguishing biodiversity. The Cuvelai drainage system is characterized by open, grassy drainage channels known as 'oshanas'. These are lined by the palm *Hyphaene ventricosa* and*Colophospermum mopane* trees dominate between the water courses. Adjoining to the south of this are the seasonally flooded grasslands on saline soils. Here the 'oshanas' converge into Lake Oponono via the Omuramba Etaka. Dominant grasses are *Odyssea paucinervis*,*Sporobolus spicata* and *S. salsus*, *Panicum lanipes*, *Monelytrum luederitzianum* and*Eragrostris* spp. To the south of this is the Etosha Pans complex which can be classified as saline desert. In years of above average rainfall, Lake Oponono drains into the Ekuma River which in turn flows into the Etosha Pan. Floodwaters can also reach Etosha via Fischer's Pan to the east, which gets its water from the Omathiya and Owambo Omiramba. The fringes of the pan are lined by sweet grassveld and *Combretum/Terminalia/Acacia* woodland.

Fauna of the Wetlands

The Cuvelai drainage is one of the most important ephemeral wetlands in Namibia, supporting 250-270 species of birds of which over 90 are wetland species. Of these, 42% are included in the Namibian Red Data Book . These threatened species include, for example, White Pelican *Pelecanus onocrotalus*, Black Stork *Ciconia nigra*, Saddlebill*Ephippiorhynchus senegalensis,* Greater and Lesser Flamingos *Phoenicopterus ruber* and *P. minor* and the globally threatened Slaty Egret *Egretta vinaceigula* (IUCN Red List, 1994). Etosha Pan is the only known mass breeding ground for flamingos (mainly Lesser Flamingos) in southern Africa. At least 25 other wetland bird species use the area as breeding grounds.

Large numbers of fish colonize the ephemeral wetlands during floods. The number of species increases from Etosha (5) to Oponono (7) and the Cuvelai (17). These fish are heavily utilized by the local people with estimates of up to 4,000kg of fish caught in a 30km section in one day. The total harvest is unknown.

Most of the large mammals in the area occur in the Etosha National Park. This includes mammal species which are considered rare in Namibia such as the Roan *Hippotragus equinus* and the diminutive Damara Dik-dik *Madoqua kirkii* and the globally threatened Black Rhino *Diceros bicornis* and African Elephant *Loxodonta africana* (IUCN Red List, 1994). Large herds of plains ungulates such as Blue Wildebeest *Connochetes taurinus* and Springbok *Antidorcas marsupialis* inhabit the plains around the pan.

Sixteen out of the 52 amphibian species known or expected to occur in Namibia, are found in the Cuvelai-Etosha system. They include such species as the Large Bullfrog *Pyxicephalus adspersus* and the colourful Banded Rubber Frog *Phrynomantis bifasciatus*. Out of 222 known reptile species a significant number are found in the area including snakes such as the African Python *Python sebae*, the Black Mamba *Dendroaspis polylepis* and Horned Adder *Bitis caudalis*. Lizards include the endemic Etosha Agama *Agama etoshae* and the Flap-neck Chameleon *Chamaeleo dilepis*.

Not much is known about the invertebrates. The largest species diversity is among the Crustacea, particularly the Ostracoda and the Crustacea form, by far, the greatest biomass. Numerous molluscs are also found.

Threats to the Area

This northern wetland system supports about 45% of the population of Namibia and population density may exceed 100 people per km2. The economy of the region is principally based on subsistence farming of millet, on livestock, fishing of the oshanas and migrant labour. Wood is the main construction material and this has led to deforestation problems, especially in the central Cuvelai area. Population growth, as in many other African countries, is the single most important threat to the wetland. Namibia has one of the highest population growth rates in the world and this rapidly expanding population is putting increasing pressure on the northern wetland resources. Rapid urbanization around the two main towns of Oshakati and Ondangwa is also having a negative effect.

Current Status and Future Prospects

The southernmost part of this wetland system is protected in the Etosha National Park, one of the oldest parks in Africa. The park has an area of 2.2 million hectares, about 600,000ha of which comprises the Etosha Pans complex. This area has been listed as one of the first Ramsar sites of Namibia with the option of extending the Ramsar site in future to cover the entire Cuvelai-Etosha system, making it one of the biggest Ramsar sites in the world (3 million hectares).

The Etosha Pan, Lake Oponono and Cuvelai drainage wetland system is biologically one of the richest and most diverse areas in Namibia, eclipsed perhaps only by the Caprivi region. This, coupled to the fact that the area supports almost half the population of Namibia, makes it one of the most important areas in this country. Namibians are fortunate that a considerable proportion of this is included in the Etosha National Park but serious consideration needs to be given to the implementation of conservation measures for the remainder. The Ministry of Environment and Tourism has formulated several policies, under the umbrella of land-use planning, in this regard. Also, Namibia's environmental legislation is currently under review and will include specific sections pertaining to the conservation of wetlands.

With the possible listing in future of the entire system as a Ramsar site, the area has great potential to become one of the showcase Ramsar sites in the world incorporating all the Ramsar principles such as wise use, conservation and training.

Case Study 2: Senegal

Djoudj National Bird Park

By Seydina Issa Sylla, National Parks, and Demba Baldé, IUCN, Senegal

Wetlands in West Africa

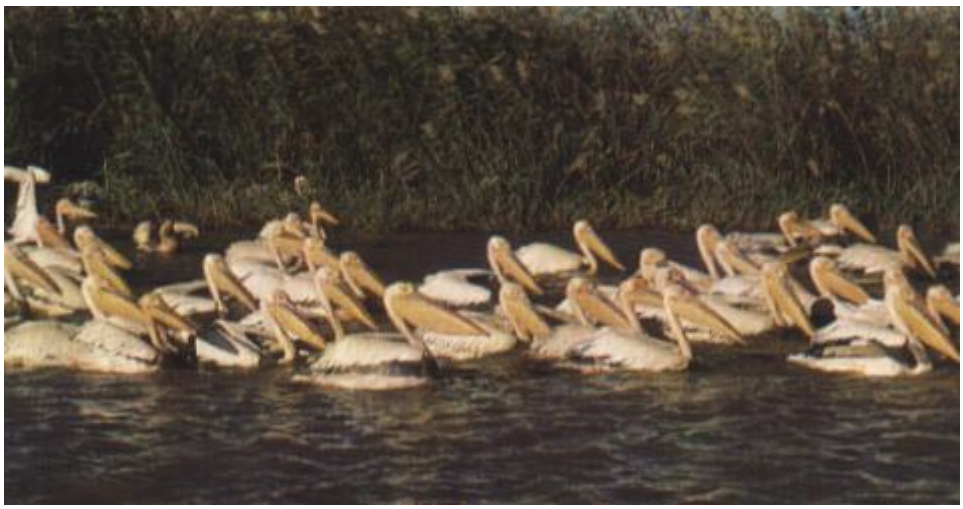
Djoudj National Bird Park is an area of 16,000ha adjacent to the Diawling National Park in Mauritania along the Senegal River. Created in 1971, the park was declared a Ramsar site in 1980 and a UNESCO World Heritage site in 1981.

Djoudj is part of a network of wetlands in West Africa south of the Sahara. The different sites (Banc d'Arguin National Park and Diawling National Park in Mauritania; and Djoudj National Park, Trois Marigots, Ndiael, Marigot of Rosso, the Gueumbeul Reserve, the Langue de Barbarie in Senegal) are interconnected by the erratic movements of their migratory birds. This western network of wetlands is ecologically connected to the Inner Niger Delta. For example, the Lesser Flamingo, *Phoenicopterus minor*, is typically seen in the Senegal Delta at the beginning of the migratory period (November-January) and in the Inner Niger Delta when the climatic and related food conditions change at the end of their migratory period (February-March). This is the reason why the conservation and management of this network should be undertaken from a global perspective rather than in isolation.

The Djoudj National Bird Park plays a significant role in this network with regard to its biological and socio-economic importance. Djoudj is at the heart of the Senegal River Delta and as such is influenced by the Diama dam and the promotion of rice agriculture in the Senegal River Delta. Therefore, its environmental monitoring will be useful for this network of wetlands in West Africa.

Biological Importance of Djoudj

The park is one of the main habitats for migratory birds in West Africa. It hosts about three million birds per year composed of 366 different species including such species as Garganey*Anas querquedula*, Shoveler *Anas clypeata*, Pintail *Anas acuta*, Black-tailed Godwit *Limosa limosa*, Greater and Lesser Flamingo *Phoenicopterus ruber* and *P. minor*, Great White Pelican *Pelecanus onocrotalus*, and Avocet *Recurvirostra avosetta*. It is an important breeding site for Great White Pelican, Purple Heron *Ardea purpurea*; Egyptian Goose*Alopochen aegyptiacus*; and White-faced Tree Duck *Dendrocygna viduata* as well as many other species.



Great White Pelicans at Djoudj National Bird Park *(Photo: Seydina Issa Sylla)*

Djoudj is a scientific laboratory for numerous researchers around the world, particularly for the study of migration and ringing. There have been about 56,000 to 70,000 birds ringed in two years.

There are 30 plant species of which *Acacia nilotica* represents an important nesting site for some species such as Great White Egret *Egretta alba*, Yellow-billed Egret *Mesophoyx intermedia*, Little Egret *Egretta garzetta*, Green-backed Heron *Butorides striatus*, Wood Ibis *Mycteria ibis*, Pink-backed Pelican *Pelecanus rufescens*, White-breasted Cormorant*Phalacrocorax lucidus*, and African Darter *Anhinga rufa*. The presence of these birds indicates a great biodiversity in fish species in the Djoudj; about 60 species have been recorded in the park. The most delicate issue is the availability

of food for Great White Pelicans (13,000 pairs), cormorants, and darters. For example, we know a pelican eats about 700 - 800g of fish per day.

Socio-economic Values

About 3,000 people live around the park and many of them make use of the park's natural resources. Thus, during the long dry season herds of cows are often seen in the park where their owners have taken them to graze on the park's resources. Fishing is an important source of food and an additional source of income for villagers, and fishermen are frequently found in the Djoudj sluices. Women of the area collect different plant species such as*Nymphea* sp. for food, *Salvadora persica* for traditional medicine, the sedge *Cyperus articulatus* and the bulrush *Typha australis* for commercial mat production, and firewood. Many activities such as fishing, grazing, gathering of forest products such as firewood, have been made illegal by the park administration in order to eliminate competition between wildlife and people. In spite of this ban, these activities, which are of socio-economic importance to the local people, do persist and have a significant impact on the park's natural resources.

The impact of tourism is not significant in the Djoudj. The park hosts an average of 3,000 tourists per year during the bird season from November through April. Hunting by both tourists and villagers is tightly regulated and warthogs and ducks are the most common game species around the Djoudj.

Major Threats to Ecosystem Integrity

The major threats facing the park are related to changes in habitat due to the construction of the dikes and dams for the promotion of rice agriculture on the Senegal River valley. These human activities have brought about changes in the quality of the water (fresh water) and therefore the biological diversity of the ecosystem. For example, the tree *Acacia nilotica* is endangered year-round by the presence of freshwater. Moreover, the development of two aquatic plants, the bulrush and Water Lettuce *Pistia stratiotes*, is due to changes in water quality as the brackish water becomes fresher and stays longer in the park.

The construction of dikes for agricultural production has ecological consequences compounded by the fact that fertilizers and pesticides are frequently used to improve yields and control pests damaging rice fields. It is believed that the use of these chemical products is also negatively affecting the Djoudj ecosystem. Because of the country's official policy of rice production for national food security and the building of the Diama dam, there is considerable land tenure pressure in the Senegal River Basin including regular encroachments of agricultural rice fields into the buffer zone of the park.

Djoudj is like an oasis in the Senegal River Delta. Because the area is experiencing desertification, there has been an immediate effect on the ecosystem as sand dunes advance from the northeast and south along the river. The Grand Lac of Djoudj has slowly filled with sand over the years causing it to dry up quickly in any given year. This has a negative impact on the length of stay of ducks, flamingos, and spoonbills.

With the construction of the Diama dam to protect the delta, the closing of the Manantali dam for regulating river flow and creation of the reservoir, and other dike constructions or improvements, Djoudj is undergoing profound environmental changes affecting its biodiversity. The area is also facing unprecedented socio-economic changes accelerated by the geopolitical situation of the region and the implementation of structural adjustment programmes. The newly designed Djoudj management plan is aimed at addressing these complex issues as Djoudj is an important wetland in the West African network.

Case Study 3: South Africa

The St. Lucia System

By Geoffrey I.Cowan, Department of Environmental Affairs and Tourism, South Africa

Location and Description

The St. Lucia System is found at the southern end of the Mozambique Floodplain and has a subtropical climate, warmed by the Agulhas current. Biogeographically, it lies at the interface between tropical and temperate biota, providing the northern distribution limits to a number of temperate species and the southern distribution limits to a number of tropical species. It has a high species diversity partly as a result of this position but also because of variability in both physical characteristics and soil conditions.

Extending over 155,000ha the St. Lucia System is the largest estuarine system on the African continent, and the wetlands form critical habitats for a large number of species and several communities. It contains, for example, the largest populations in South Africa of the Common Hippopotamus *Hippopotamus amphibius*, Nile Crocodile *Crocodylus niloticus*, Great White Pelican *Pelecanus onocrotalus* and Pinkbacked Pelican *Pelicanus rufescens*, as well as extensive *Cyperus papyrus* swamps, and *Barringtonia racemosa* swamp forest. The wetlands have an extremely high productivity, and are regarded as an outstanding area for wildlife.

The Fauna and Flora of the St Lucia System

Consistent with its environmental diversity, the St. Lucia System encompasses a huge diversity of wetland habitat types. No other place in southern Africa within an equivalent area has such a diversity (Box 5).

Box 5: The Major Wetland Communities and their Characteristic Species in the St. Lucia Wetlands

Freshwater reed and papyrus swamps (*Phragmites australis* and *Cyperus papyrus*);

Saline reed swamps (*Phragmites mauritianus*);

Sedge Swamp (*Eleocharis limosa*);

Saltmarshes (*Sporobolus virginicus*, *Paspalum vaginatum*, *Juncus krausii*,*Salicornia* spp. and *Ruppia maritima*);

Submerged macrophyte beds (*Potamogeton pectinatus*, *Ruppia cirrhosa* and*Zostera capensis*);

Echinochloa floodplain grassland (*Echinochloa pyramidalis*, *Eriochloa* spp.,*Sorghum* spp. and *Cyperus* spp.);

Low-lying grasslands on clay substrates (*Themeda triandra*, *Sehima alpinii*and *Cynodon dactylon*);

Hygrophilous grasslands on sandy substrates (*Acroceras macrum* and*Ishmaemum arcuatum*);

Riverine woodlands (*Ficus sycomorus*, *Acacia xanthophloea*, *Rauvolfia caffra*, *A. schweinfurthii*, and *Azima tetracantha*);

Mangroves (*Bruguiera gymnorrhiza* and *Avicennia marina*);

Swamp forest (*Ficus trichopoda, Voacanga thouarsii, Syzigium cordatum, Barringtonia acemosa, Phoenix reclinata, Macaranga capensis, Bridelia micrantha, Psychotoria capensis, Tarenna pavettoides, Psilotum nudum, Stenoclaena tenuifolia*, and *Nephrolepis biserrata*).

The range of wetland types (13 according to the Ramsar classification of 1990) is remarkable, both in terms of the diversity within each type of wetland, as well as the considerable variability in diversity between types; the result is a highly variable community structure and composition. This is even more remarkable if one considers that the complex of interlinked wetlands extends across the complete salinity gradient from freshwater to marine to hypersalinity conditions.

In terms of its animal life, St Lucia is not only known for its large populations of crocodile, hippopotamus and pelicans but also its particularly rich diversity of other animal groups. Within the wetlands some 52 dragonfly species have been recorded, 38 freshwater fish species, 182 estuarine fish species and 50 amphibians. Over 350 species of bird have been recorded within the site, 90 of which are wetland birds, including at least 20 species of ducks and geese, 2 species of flamingo, and some 15 species of herons and egrets.

Utilization and Main Threats

Man's primary usage of the wetland system is through a substantive recreational fishing industry, supported by a commercial prawn fishery and mullet fishery (for bait) in the estuary itself. In the estuary strictly controlled harvesting of Ncema *Juncus krausii* and reeds for traditional weaving also takes place. The St. Lucia System is recognized as one of the most popular bird-watching sites in South Africa.

The controversial dune mining proposal is considered as the main threat to the site. A Ramsar Monitoring Mission visited the site in 1991. The fact that the St. Lucia System is a Ramsar site (designated in 1986) has contributed to ensuring a proper planning procedure is being followed and a decision regarding this proposal is pending. Degradation of the catchment areas of the Mfolozi and Mkuze rivers, although outside the site, is also some cause for concern.

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Case Study 4: Tunisia

Sebkhet el Kelbia

By Fethi Ayache, Ministry of Environment and Land Use Planning, Tunisia

The Sebkha of North Africa

Sebkha is a North African vernacular name for a shallow, salty depression. It is a common wetland type especially in semi-arid and arid climates but less so in sub-humid climates. In Tunisia, about 80 wetlands of this type stretch from north to south, most of them located within a short distance of the coast although not usually connected to the sea. They play a major hydrological role in stocking flood waters, recharging and/or discharging groundwater and are prime habitats for a diverse and typical fauna and flora thus generating many benefits to local communities and society as a whole.

Sebkhet el Kelbia

Sebkhet el Kelbia is 20km inland at the limit of two geographical regions: the Sahel (coastal area) of Sousse and the lower steppe of central Tunisia. The marshes and the lake occupy a maximum area of 14,000ha and drain a catchment area of 15,000km2. The Sebkha is state-owned and 8,000ha of it were declared a Nature Reserve in 1993. The climate is semi-arid with an average annual rainfall of 200mm, a mean temperature of 20ûC and a high evaporation rate. The water is slightly saline and it is one of the rare wetlands of this type which does not develop a salt crust when it is dry. During exceptionally heavy rains, the Sebkha discharges into the sea via the Oued Sed which develops some densely vegetated pools along its course. These are rich in birds such as Purple Gallinule *Porphyrio porphyrio*, several species of warbler, including Great Reed Warbler *Acrocephalus arundinaceus*, Sedge Warbler *A. scirpaceus*, and Moustached Warbler *A. melanopogon*, and the threatened Marbled Teal *Marmaronetta angustirostris* (IUCN Red List, 1994). It regularly dries out for several years at a time. Six overflows were recorded this century, the latest was in 1989/1990.

The Values of the Wetland

Floral values. Vegetation grows around much of the water body in concentric rings which may possibly be related to salinity, wetness, or both. At the delta of Oued el Ataf the pattern is more of a mosaic. A representative profile would show the following succession: typical aquatic genera *Althenia* and *Zanichellia*, succeeded by annuals such as *Salicornia* and*Salsola* near the immediate water fringes through perennials such

as *Arthrocnemum*,*Halimione* and *Suaeda* to *Typha, Tamarix and Juncus*, on the drier parts between the muddy areas and the surrounding cultivated land.

Faunal values. The high production of the biomass, due in part to the alternating wet and dry periods of the Sebkha, attracts large populations of wintering, migrating and nesting birds. The maximum number counted is 271,000 including several species of duck, many waders and a variety of other waterbirds. It is a major roosting site for the Crane *Grus grus*with up to 5,000 having been counted. Breeding birds include Little Grebe *Tachybaptus ruficollis*, Great Crested Grebe *Podiceps cristatus*, Shelduck *Tadorna tadorna*, Black-winged Stilt *Himantopus himantopus*, Avocet *Recurvirostra avosetta*, Pratincole *Glareola pratincola*, Whiskered Tern *Chlidonias hybrida*, and Marbled Teal with occasional breeding of Gull-billed Tern *Sterna nilotica* and the threatened White-headed Duck *Oxyura leucocephala* (IUCN Red List, 1994). During the latest floods which lasted more than two years, more than 100,000 birds including about 10,000 Greater Flamingo *Phoenicopterus ruber* were wintering and a few thousand were found nesting.

Receding floodwaters in the Kelbia marshes with flocks of birds overhead*(Photo: Imed Essetti)*

Hydrological values. The Sebkha plays a significant role as a natural buffer zone preventing the disruptive impact of floodwaters on human activities. In addition, evidence of a drop in the level of wells since the last flood of 1990 indicate some role of the wetland in recharging the groundwater table.

Socio-economic values. Grazing is very common on the fringes and marshes of the Sebkha. It forms an integral part of the grazing cycle in the region especially in summer time when other pastures are exhausted. In addition, since the Sebkha holds floodwaters for a year or more, extensive grazing areas appear as the flood retreats and the area can become of great significance during drought years. As the flood recedes, local farmers benefit by cropping the outer parts of the wetlands as the silt deposition makes the area very productive. Fishing used to be quite a thriving activity with an average landing of 80 tonnes per year. Lastly, there is evidence of wood collection from the stands of Tamarix fringing the lake .

Threats to the Integrity of the Sebkhet el Kelbia

Damming of the three main rivers upstream (at Nebhana in 1965, Sidi Saad in 1981, El Haoureb in 1988) was carried out to control floodwaters and this has cut off all river inputs except for overflows from these dams and the lower part of the catchment. Despite some overflow from the Sidi Saad dam and the exceptional flooding of 1989/1990, the net result has been that the desiccation of the Sebkha has become 2.5 times more frequent than in the past and, before the last flood of the Sebkha in 1989/1990, the wetland had been dry for more than 10 years.

As a result of the continuation of engineering work within the plain of Kairouan, a proposal has been made to reclaim the upper part of the wetland for agricultural and/or pastoral use and to cut a channel through the lower part of the wetland towards Oued Sed which would be dredged.

Siltation is also a problem since much of the vegetation of the hillsides in central Tunisia is heavily degraded. However, subsidence is partly offsetting the rising level of the lake bottom.

A large concentration of birds attracts hunters and despite the designation of part of the area as a nature reserve, hunting still carries on unabated. Equally, the collection of eggs is so acute that some species have been significantly affected: for example hundreds of pairs of Marbled Teal were nesting in 1990 but very few were successful in raising their chicks.

Another current problem is rubbish tipping from the nearby small town of Kondar, and the discharge of olive oil residue from factories. This is actually quite limited in extent at the present time but could become significant in the future since waste disposal is continuing.

At the fringes of the Sebkha extensive grazing takes place and this causes some disturbance of the surrounding vegetation which is a prime habitat for nesting waterfowl.

Future Prospects

Kelbia is a potential tourist attraction in terms of the wintering and nesting populations of birds, panoramic views, and recreational opportunities. The large tourist industry at the Gulf of Hammamet (Nabeul, Hammamet, Sousse and Monastir) is within 30 to 80km of the site. Adequate management of the wetland, an appropriate administrative structure as well as an educational programme could be of great value in the development of Kelbia, boosting tourism during the low season in autumn and winter and providing an outdoor leisure and educational site for the population of the region.

However for this kind of development a larger area of the Sebkha needs to be given the status of nature reserve or national park. In addition, since Kelbia largely fulfils the criteria for a Wetland of

International Importance in terms of the size of wintering population or number of species, its status could be reinforced by listing Sebkhet el Kelbia as a Ramsar site. The current and potential threats to the site should be addressed urgently especially the drainage project, the control of water flow from the catchment into Kelbia and appropriate on-site protection**.**

Case Study 5: Uganda

Lake George

By Paul Mafabi, National Wetlands Conservation and Management Programme, Uganda

Introduction

Uganda ratified the Ramsar Convention in 1988, and designated Lake George a Ramsar site. Located astride the equator, the lake and associated wetlands support a wide variety of biological resources. The reasons for this are varied, ranging from the good climate to shallow stratified waters (average 2.4m) which allow for a thorough mixing of the different layers, and a high alkalinity and photosynthetic activity.

The status of Lake George is varied with most of the wetlands fringing the Lake being part of the Queen Elizabeth National Park. The open water of the lake is not part of the National Park and is managed by the Fisheries and Water Departments. This has had implications for management because of inter-sectoral inconsistencies.

Lake George is renowned both for its high productivity and its flagship species such as the Shoebill *Balaeniceps rex*. Over the years the lake has attracted a lot of attention: it was part of the International Biological Programme in the late 1960s; it is located within the Queen Elizabeth National Park which is a Man and the Biosphere Reserve of UNESCO; and finally the listing of Lake George as Uganda's first Ramsar site was further recognition of the importance of the lake as a centre for biological diversity. Decades ago the initial management interest was in commercial fisheries on the lake. Today, the commercial fisheries are on a much smaller scale supplying mainly local needs, the management focus has changed considerably, and the lake has become an important tourist destination.

Diversity of the Wetland

Seen from the air, the waters of Lake George appear green as a result of thick concentrations of blue-green algae. The entire lake can be considered as a wetland since its average depth is about

2.4m and it hosts a mosaic of wetland types dominated by Papyrus swamps *Cyperus papyrus*. Around the edge of these swamps is a dense fringe of the wetland grass *Vossia cuspidata*. *Vossia* forms mats which are anchored to the lake bed whereas Papyrus is either emergent in shallow water or forms thick, floating mats which extend into deeper waters. These support Black Crakes *Amaurornis flavirostra* and Malachite Kingfishers *Alcedo cristata*.

A rare plant found in the area is the cycad *Encephalartos hildebrandtii*. This primitive fern-like plant is known only from the gorge of the Mpanga River to the east of Lake George and from an area on the East African coast. The other plant not commonly found in Uganda is the sedge *Cladium mariscus* which forms swamps around Lake George; its only other known location is in some pockets in the Kigezi region of southwestern Uganda.

Lake George wetlands provide habitat for over 150 species of birds including some rare species. These include the Saddle-billed Stork *Ephippiorhynchus senegalensis*, seven 'papyrus endemics' including Papyrus Gonolek *Laniarius mufumbiri*, Papyrus Canary*Serinus koliensis*, and the threatened Papyrus Yellow Warbler *Chloropeta gracilirostris*(IUCN Red List, 1994). The Madagascar Squacco Heron *Ardeola idae* has also been recorded within the Lake George Basin. The associated crater lakes provide the only habitat for Greater and Lesser Flamingos *Phoenicopterus ruber* and *P. minor* in Uganda.

The most spectacular of all is the Shoebill, a very large, grey water bird with a gigantic shoe-shaped bill. It is often confused with members of the stork family because of its resemblance to storks but it is in fact the only species within the family Balaenicipitidae. It is found in an enclave of the Lake commonly referred to as Shoebill Swamp.

Utilization of Lake George's Resources

The potential of Lake George is not yet fully exploited largely because of its inaccessibility. Nevertheless, Lake George wetlands are utilized in several ways. The Lake supports a thriving fishery with more than 50 species recorded in catches. Most of these are cichlids of which the most abundant is the phytoplankton-eating *Haplochromis nigripennis*. Up to 3,500 tonnes of fish were recorded annually between 1952 and 1972, and the catches are equally high in recent years. There is low endemicity compared to other lakes in the region. The most common fish include; tilapias, the catfish *Clarius lazera* and *Bagrus docmac*, a species of lungfish *Protopterus* sp., the electric fish *Mormyrus kannume* and the cichlid*Haplochromis squamipinis*. The presence of large quantities of fish led to the establishment of a fish factory in the 1960s to process tilapia. Although the factory is now disused and the scale of commercial fisheries has diminished, the lake still supports important fishery activities. Fishing villages are established in several of its bays, supplying fish

locally to Kasese town and the surrounding area and to far destinations such as Kampala (450km away) and Zaire to the west.

The other important human activity is the harvesting of Papyrus and the woody plant Ambatch, *Aeschynomene elaphroxylon* which grows in marshy soil, in swamps and on the edge of the lake. Papyrus is used for roofing material and screens while Ambatch stems, with their cork-like texture, are used as floats and buoys for fishing nets.

Tourism is another activity that occurs in the area, but to a lesser extent because most of the wetlands are inaccessible due to the impenetrable swamp forest.

Threats to the Diversity of the Area

There are some problems which threaten the high diversity of the area and could jeopardize its existence if appropriate measures are not taken in time to address them:

- The lake is affected by pollution from copper and cobalt pyrites as the site is close to a copper mine and many of the rivers and streams that feed into the lake go past the mine. However the establishment of Kilembe Cobalt Company to carry out cobalt production using bioleaching and solvent extraction and electro-winning is expected to address some of the problems of cobalt pollution through rehabilitation of the degraded environment.

- There is uncontrolled charcoal burning to the east of the Lake George wetlands which could become disastrous if not checked: this is bound to deplete the tree resources of Lake George leading to loss of the natural organisms which they support.

- Horticultural activities such as vegetable growing to supply the fast growing Kasese town, also pose a threat to the lake and its associated wetlands. Many of these activities involve modification and in some cases drainage of wetlands and could reduce the buffering capacity of the wetlands. In addition the use of pesticides and agrochemicals in horticulture pose a danger to Lake George's biodiversity.

- There is a potential problem of silting from poor management practices in the water catchment area of the wetland as a result of intensive agricultural activities in the surrounding slopes of Mt Ruwenzori to the north, and the Bunyaruguru escarpment to the south.

Although Lake George supports a high diversity of biological resources and a high human population which is dependent on the fishing, the future of the lake, in the face of these threats, is

uncertain. However recent government policy on wetlands in particular and the environment in general provide hope for the future.

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CHAPTER 4

THE ASIAN REGION

An Overview of Asian Wetlands

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The Asian Region

Asia is a vast continent stretching almost half-way around the world. Fringed by more than 20,000 islands mainly in the Southeast Asia archipelago, it is home to about 60% of the world's population even though it only comprises about 30% of the world's land surface. (Geographically, the western border of the Asian Ramsar Region runs along the Ural Mountains, the Ural River and the northwest shoreline of the Caspian Sea). The climatic and ecological variation in the region is extremely high ranging from the frozen Siberian tundra to the tropical coasts of Southeast Asia, and from the scorching deserts of West Asia to some of the world's wettest and most flood prone regions in the lower Ganges-Brahmaputra Valley.

The high population density has led to a long historical dependence on wetland resources: the major human civilizations of the world evolved in river valleys and wetlands in the region, such as the Tigris-Euphrates Valley in Iraq, which 6,000 years ago was the legendary site of the Garden of Eden; the lower Mekong floodplain, site of the Khmer Kingdom 2,500 years ago; and the fertile

floodplains of India and China upon which their respective empires were founded. This dependence on wetlands continues till the present time - in India and China, for example, hundreds of millions of people still depend on wetland crops and fish as their main sources of food - but brings with it heavy pressures and a range of threats to the integrity of the wetland ecosystems. Thus, wetlands in the region are characterized by their close interaction with local human communities: only in the remote parts of China, Mongolia, or Russia are there wetlands which are relatively unused or undisturbed by man.

Thirteen states within the region are Contracting Parties to the Ramsar Convention (this does not include Russia which is considered a Contracting Party of the Eastern European Region). The Contracting Parties of the region have designated 57 wetlands as Ramsar sites covering approximately 3.2 million hectares; this includes Mai Po Marshes in Hong Kong, designated by the U.K. Government. Not yet included are a number of large sites in Russia (which are geographically considered to be part of Asia) which have still to be clearly defined in terms of area. The Ramsar sites in the region vary in area from the 10ha Katano-kamoike wetland in Japan to the 1.89 million hectare Parapol Valley in the Russian Federation, and cover a wide range of wetland types from desert oases to Siberian tundra and tropical swamp forest.

Wetland Types and their Distribution in the Region

In the tropics, two of the most important types of wetlands are mangroves/mudflats and peat/freshwater swamp forests. The mangrove/mudflat ecosystem used to cover much of the tropical Asian shoreline. Mangroves comprise a group of about 60 species of salt-tolerant plants which are able to thrive along sheltered, muddy coastlines. Along with their adjacent mudflats, these wetlands are extremely productive and are important for large numbers of wildlife species and as breeding, nursery or feeding ground for up to 70% of coastal fish and prawns. This ecosystem is vitally important for resident birds, such as storks and herons, and migrants, such as waders and egrets, as well as supporting a diverse mammal fauna.

Swamp forest occurs inland of the mangroves in freshwater conditions. Freshwater swamp forest occurs on permanently or seasonally flooded mineral soils often in zones up to 5km wide along rivers or around freshwater lakes. Peat swamp forests cover large areas in between river basins in Borneo, Sumatra, Peninsular Malaysia and Irian Jaya. The litter in these forests has accumulated to form a layer of peat up to 20m thick. Peat and freshwater swamps support a wide variety of plant species, many restricted to this specialized habitat, and they support a great diversity of freshwater fish, birds and mammals.

In temperate regions the most common wetlands are lakes and marshes. North Asia in general, and Siberia in particular, include some of the most extensive wetlands in the world. The tundra region

consists almost entirely of fens and bogs interspersed with lakes, river valleys and coastal estuaries. In Western Siberia the Ob floodplain covers 5 million hectares and is one of the largest breeding and moulting grounds of waterbirds in Eurasia.

It is estimated that there are at least 120 million hectares of wetlands of international importance in South and East Asia. An inventory of wetlands in 24 countries in South and East Asia, conducted from 1985-1988, describes 947 wetlands of international importance and a similar inventory in the Middle East, conducted in 1995, details 221 such wetlands in West Asia. Information on the wetlands of Russia and the Central Asian Republics is still in preparation.

Wetland Protection and Current Threats

An assessment of the degree of protection of wetlands of importance from the above inventories indicates considerable variation between sub-regions with 21% (by area) protected in South Asia, 14 % in Southeast Asia, and 12% in East Asia but there are wide variations between countries within each of these sub-regions. The country with the largest area of 'totally protected' wetlands is Indonesia (2.9 million hectares) while a number of countries have less than 1% of their important wetlands totally protected including Cambodia, Laos, Malaysia and Vietnam.

Despite the amount of protection afforded sites in certain countries in Asia, the great majority of the natural wetland ecosystems in South, Southeast and East Asia are under threat. Some information has been obtained on the level and nature of threat at 734 of the 947 wetlands of international importance. About 85% of the sites are threatened in some way and nearly 50% are moderately or severely threatened. Wetlands in South Asia (93%) and Southeast Asia (94%) are considerably more threatened than those in East Asia (66%). Wetlands are under particularly severe pressure in Malaysia (85%), and the Philippines (69%). Sites in West Asia are also under severe pressure; for example, 50% of wetlands in Pakistan are under moderate or severe threat.

Threats to the wetlands are quite variable between sub-regions and between sites, but taking the region as a whole, the threat most frequently reported from sites is hunting and associated disturbance, closely followed by general disturbance from human settlement/encroachment and drainage for agriculture.

Wetland Biodiversity

The biological diversity of Asia's wetlands is extremely high and the region is the global centre of diversity for a number of ecosystems or species groups. It is, for example, the global centre of mangrove diversity with over 60 species of mangrove tree compared with between 7 and 12 in Africa and the Americas. Mangroves are also extremely extensive with some of the world's largest

contiguous mangrove areas such as the Indian and Bangladesh Sundarbans with approximately 650,000ha of mangrove forest. In Indonesia and Malaysia the most diverse mangrove forests in the world are found, with over 200 plant species occurring in, or associated with, this ecosystem.

Coastal wetland systems here are extremely diverse and the world's most diverse coral reefs (in terms of reef-building coral species and reef fish species) occur in the region. More species of sea grasses are also found in this region than in others. These rich and varied habitats in turn support an abundance of vertebrate and invertebrate animals.

The freshwater and peat swamp forests of Southeast Asia, which are the largest and best developed in the world, are botanically also very diverse with many species restricted to these habitats. Vegetation studies in the Berbak National Park, a Ramsar site in Sumatra, Indonesia, found more than 150 tree species in a plot of one-tenth of a hectare. This park is also thought to be one of the world's most highly diverse areas in terms of palm species. Peat swamp forests cover nearly 30 million hectares in the sub-region compared with 1 million hectares in Amazonia.

Danau Sentarum in Indonesia - a Ramsar site - is an 80,000ha freshwater lake and swamp forest ecosystem. So far more than 230 species of freshwater fish have been recorded, including over 10 species new to science discovered in the past two years. Other vertebrate groups also occur in wetlands in large numbers - 220 bird species or 60% of the avifauna of Sumatra have been recorded in wetlands of which a large proportion is confined to these habitats. A number of mammals are restricted to wetlands, including for example, otters, dolphins, dugong, and several cats and civets. While northern Asian wetlands support rather few wetland mammals, wetlands in southern Asia are home to a great diversity of mammals which are dependent on the wetlands for their survival, including quite a number of threatened species such as the Dugong *Dugong dugon*, Hairy-nosed Otter *Lutra sumatrana*, and Chinese River Dolphin *Lipotes vexillifer* (IUCN Red List, 1994). The majority of amphibians and many reptile species (including crocodiles, freshwater turtles and tortoises) are found in wetlands and some are considered threatened: for example, of the 12 crocodilian species listed as threatened by the IUCN Red List, 7 are Asian species.

Invertebrate diversity is extremely high as the majority of invertebrate phyla are aquatic or predominantly aquatic. Any one wetland in tropical Asia may support thousands of invertebrate species, many of which have yet to be discovered. Recent invertebrate sampling in Hong Kong's Ramsar site, Mai Po Marshes (Case Study 3), has revealed that over 10% of invertebrates were undescribed in this relatively intensively studied part of Asia.

All of this biological diversity is of great value to one of the most ubiquitous wetland species,*Homo sapiens*. In Peninsular Malaysia alone, over 500 (or 50%) of the plant species in freshwater wetlands are of known socio-economic value. Apart from the immense importance of wetland

species for food, fodder, clothing, and shelter, new uses for medicinal and industrial purposes are being found every month for naturally occurring chemicals in wetland plants. The economic value of these systems is very large: in Malaysia the total annual contribution of wetlands to the economy through direct and indirect means is valued at US$2 billion while the wetlands of the lower Mekong contributed US$90 million to the economy, and supplied 50-70% of the protein needs of the region's 20 million people in 1981.

The Asian Case Studies

The case studies in this chapter illustrate the variety and importance of wetlands in the region. The first case study examines the Sundarbans mangrove; the world's largest mangrove system and of importance to the livelihood of over 300,000 people. The second case study, Dongdongtinghu in China, illustrates the complexities of wetland management with over 500,000 people living in and around the wetland and many competing demands for resources. In Mai Po Marshes in Hong Kong, the third case study, a wide range of natural and man-modified coastal wetland habitats is of critical importance for migratory species. Considered next is Keoladeo National Park, where a conservation education project is helping local people understand the conservation issues within the park and where efforts are being made to involve them in finding solutions to the park's management problems. Following this is Kushiro Marsh in northern Japan where the unique species of the site, especially the Red-crested Crane *Grus japonensis*, attracts thousand of tourists to the region every year. The sixth case study from Azraq Oasis, Jordan, illustrates the importance of wetlands in arid regions and their vulnerability to external impacts such as over-pumping of water from the basin. Finally, the Tasek Bera Ramsar site in Malaysia describes the high species diversity of a tropical lake/swamp forest ecosystem and the need for good catchment management to preserve it.

Taken together, the overview and case studies illustrate the richness of wetland sites in Asia in terms of biological diversity, and the importance of preserving them for the livelihood and enjoyment of this and future generations.

Ramsar in Asia

Two successive Meetings of the Conference of the Parties to the Ramsar Convention in two influential countries in the region, namely Japan in 1993 and Australia in 1996, have been effective in raising the awareness in many Asian countries of wetland conservation in general and the Ramsar Convention in particular. To add to this increasing awareness, there have been various environmental education campaigns relating to wetland conservation in many countries in the region. A positive result of this is that the number of Contracting Parties to the Convention is increasing: the Governments of Cambodia, Republic of Korea, and Thailand have officially

announced their intention to become members of the Convention and Bhutan has informed the Ramsar Bureau that it is preparing to do so.

A number of Contracting Parties, including China and Malaysia, as well as non-member states are in the process of developing National Wetland Policies, Strategies or Action Plans. However, the growth in the number of Ramsar sites in the region is rather slow and governments, NGOs and the private sector will have to make great efforts to maintain the ecological character of precious wetlands in the region.

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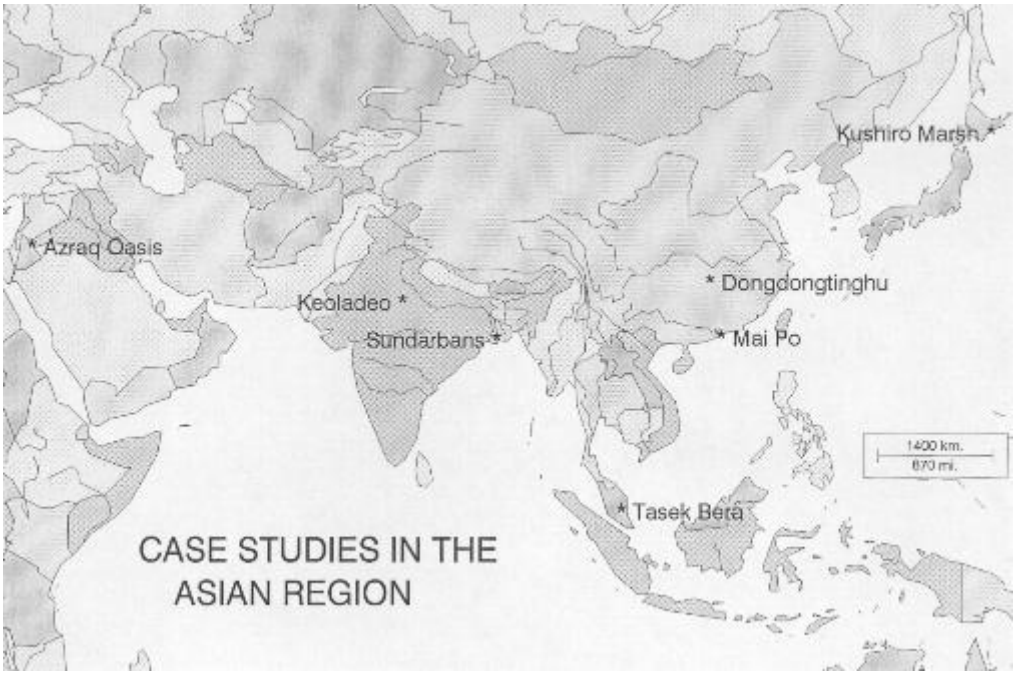


Case Study 1: Bangladesh/India

The Sundarbans

By Zakir Hussain, IUCN - The World Conservation Union, Thailand

Introduction

The Sundarbans constitutes the single largest piece of mangrove forest in the world. The entire area extends to around one million hectares and includes approximately 650,000ha of mangrove forest. Located in the Gangetic Delta in southwestern Bangladesh and the adjoining areas of the State of West Bengal in India, the Sundarbans is very rich in floral and faunal diversity and has profound economic importance for the people of the neighbouring districts. It has additional importance in that it acts as a physical barrier to the frequent storms arising in the Bay of Bengal, protecting communities in the hinterland. The forest is acknowledged as one of the oldest examples of 'wise use' of wetland resources, having been managed sustainably for over 100 years. The Bangladesh portion of the Sundarbans includes 407,000ha of mangroves and is the only Ramsar site in the country while the Indian portion is a World Heritage site.

Biotic Diversity

123 species of higher plants including a number of economically important species have been recorded from the Sundarbans. The most abundant mangrove tree species are*Heritiera fomes, Excoecaria agallocha, Ceriops decandra* and *Sonneratia apetala.* A wide range of palms, grasses, ferns and epiphytes are also found here. The most extensively occurring palms are *Nypa fruticans* and *Phoenix paludosa* while *Eriochloa procera* and*Phragmites karka* are the most common grasses. Thirteen species of orchid and seven species of fern occur in the forest. There is also a large number of climbers, creepers and shrubs in addition to the numerous algal and fungal species that occur on the wet forest floor and tree trunks.

A total of 425 vertebrate species (excluding fish) have been recorded in the Sundarbans, including 49 species of mammals, 53 species of reptiles, 315 species of birds and 8 species of amphibians. Although less well documented, the area also supports a whole array of moths, butterflies, wasps, beetles and other invertebrates.

The Sundarbans is the single largest continuous area in the world for the threatened Bengal Tiger *Panthera tigris tigris* (IUCN Red List, 1994) and available information estimates that 350 individuals occur in the Bangladesh portion of the forest with a slightly lower number in the Indian

portion. The Sundarbans is also home to three other felid species, the Jungle Cat*Felis chaus*, Leopard Cat *Felis bengalensis,* and Fishing Cat *Prionailurusviverrinus*.

Other important mammals of the Sundarbans include the Spotted Deer *Axis axis*, Barking Deer *Muntiacus muntiac*, Wild Pig *Sus scrofa* and Rhesus Macaque *Macaca mulatta*. There are also dolphin and porpoise in the Sundarbans. Reptiles of particular importance include three threatened species, the Indian Python *Python molorus*, Estuarine Crocodile*Crocodylus porosus* and River Terrapin *Batagur baska* (IUCN Red List, 1994), but the area also supports others of interest such as the King Cobra *Ophiophagus hannah* as well as a further six species of turtle and four species of monitor lizard.

The avifauna includes 117 species of waterbirds, 31 birds of prey and 2 pheasants. Eighty four migratory species also stop over at the Sundarbans. Recorded species include four which are considered threatened: Masked Finfoot *Heliopais personata*; Greater and Lesser Adjutant Stork *Leptoptilos dubius* and *L. javanicus;* and Pallas's Fish Eagle *Haliaeetus leucoryphus*(IUCN Red List, 1994)

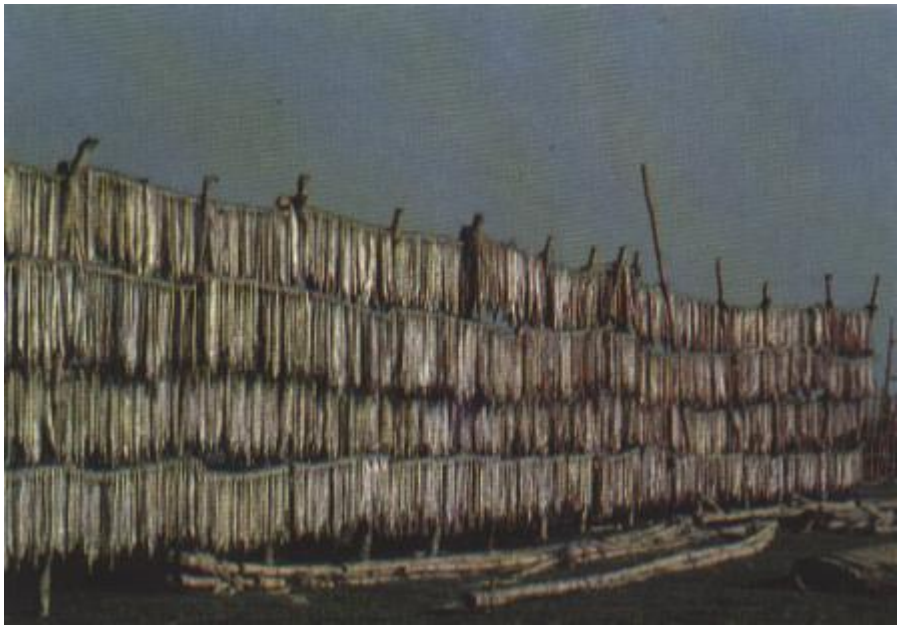
More than 400 fish species have been recorded from the Sundarbans and its adjoining coastal waters and 120 of these are regularly caught by commercial fishermen from the Sundarbans waters. There is also a rich population of molluscs and crustaceans.

Sustainable Use and Management

The scientific management of the Sundarbans for timber and other wood resources was initiated about 125 years ago. In the last few decades, non-timber forest products including thatching palm and grasses, honey and bees-wax, crustacean shells and fish have gained importance and these play an important role in the economy of the region. As a result, sustainable management regimes for both the timber and non-timber resources have been developed.

The simple management regime which is followed in the Bangladesh portion of the forest involves a 20-year exploitation cycle of the tree resources: the forest is divided into twenty compartments with each compartment harvested in turn and the cycle repeated at year 21. During the harvest, all trees above a certain diameter are removed as long as such removals do not create any permanent gaps in the forest canopy. In a subsequent operation, just after timber harvesting, all dead and deformed trees are removed in addition to a thinning of congested stands. The harvest of other tree products including fuelwood, poles and industrial wood also follow a similar pattern.

The harvest of *Nypa* leaves, which are extensively used in thatching houses in rural areas, is carried out on a 3-year cycle. Fishing and collection of honey, bees-wax and shells are also closely regulated to ensure sustainable exploitation of these resources.



Drying of fish in the forest.*(Photo: Zakir Hussain)*

The management of resources in the Sundarbans represents the implementation of the principles of 'wise use' which originated at a time in the past when sustainability was never considered as a major factor. The forest provides the main source of income for a large number of people and according to a Forest Department estimate, about 45,000 people work in the forest each day during the peak harvest season in the Bangladesh portion of the forest, while in the winter more than 10,000 fishermen establish camps in the forest to fish for three to four months. The number of fishermen involved in year round fishing is even larger. In addition to producing up to 45% of all the timber produced from state-owned forests in Bangladesh, the Sundarbans is the only source of raw materials for the only newsprint paper mill in the country, as well as a number of match and board mills and other industries. The employment generated by wood processing, retailing and transportation is also substantial.

The sustainable management of this unique ecosystem over a long period has caused very little change to the composition, quality and extent of the Sundarbans forest, particularly in Bangladesh, and it is a testimony to the success of the management techniques employed that the great diversity of flora and fauna has been maintained.

Case Study 2: P. R. China

Dongdongtinghu (East Dongting Lake)

By CHEN Kelin and YAN Chenggao , Ministry of Forestry, People's Republic of China

Location and Description

Dongdongtinghu is situated in the middle reaches of the Yangtze River in northern Hunan Province of the People's Republic of China. It is a typical freshwater lake wetland in a transitional area between the middle and northern sub-tropical climatic zones. In summer the area is a vast expanse of lake surface, but in winter this wetland is transformed into five different types of terrain: fresh water; reed marsh; sedge swamp; peat bog; and sandy beach. With a water surface covering 1,328km2, Dongdongtinghu is used mainly for water storage and channelling. Four of the major rivers in Hunan Province converge here (the Xiangjiang, Zishui, Yuanjiang and Lishui rivers), and with a drainage area of 1.3 million square kilometres it plays a vital role in controlling the water flow in the Yangtze River.

Part of the lake is protected as Dongdongtinghu Nature Reserve which covers an area of 190km2 and is managed by 58 staff members. It is one of China's six wetlands which have been designated as Ramsar sites.

Major Species

Favourable geographic and climatic conditions endow this region with an extremely rich wetland biodiversity. According to the available information, the numbers of various plant and animal groups found in this region are as follows:

Category	Shrimp/Crab	Shellfish	Fish	Amphibian	Bird	Mammal	Angiosperm	Gymnosperm
Family	5	9	23	6	41	16	138	6
Species	7	48	114	12	158	31	329	22

The vegetation in this region is made up of a range of wetland types such as submerged plants, floating plants, emergent plants, sedge meadows, willow and wormwood shrubs, reeds, deciduous broad-leaved forests, and evergreen broad-leaved forests.

The wetland is dominated by waterfowl and fishes. The majority of the waterfowl are migratory and the reserve is considered an extremely important wintering area for these birds. There are several species found here which are considered rare in China and a number which are globally threatened*

(IUCN Red List, 1994) including: Chinese Paddlefish*Acipenser sinensis;* White Stork *Ciconia ciconia*; Crane *Grus grus*; Hooded Crane* *Grus monacha*, White-naped Crane* *Grus vipio*; White Spoonbill *Platalea leucorodia*; Great Bustard* *Otis tarda*; Whistling Swan *Cygnus columbianus*; Chinese Merganser* *Mergus squamatus*; White-fronted Goose *Anser albifrons*; Bean Goose *Anser fabalis*; Chinese River Dolphin* *Lipotes vexillifer*; Finless Porpoise *Neophocaena phocaenoides*; and Clouded Leopard* *Neofelis nebulosa.*

Development and Utilization

Surrounding the wetland are the political, economic and cultural centres of Hunan Province and several major ports on the Yangtze River. The total population in the wetland area exceeds 550,000 people of which over 290,000 are rural residents. To the east of the lake is largely an urban area dominated by textile, chemical, food processing and light industries, supplemented by agricultural production, while the area to the west is mainly agricultural. The wetland resources in this region are heavily utilized and have a high potential for development:

- this wetland region is a main course for all-year-round water transport and merges, in the north, into the Yangtze River;
- the fishery resources provide the major source of income for local residents;
- the existing area of reed in this region amounts to 20,300ha. Reed cutting has become the leading industry supporting the local agricultural economy, with an annual turnover of US$ 1.25 million generated by the sale of various kinds of reed products;
- every winter, about 4,000 head of cattle and 200,000 domestic ducks are fed on the meadows and marshes of the nature reserve;
- the Yueyang Tower and Junshan Mountain in the nature reserve are well-known scenic spots frequented by almost two million people every year.

Major Existing Problems

- Being a major supporting industry for the local economy, reed cutting is being carried out unsustainably resulting in the rapid shrinkage of the winter habitat for migratory birds, some of which may even disappear if such trends continue.
- About 142 million cubic metres of sand and mud are brought into the lake every year by running water and about 75% of this is deposited in the lake.
- Some 240 million cubic metres of industrial and domestic waste water are discharged into this wetland reserve. Of particular importance is the direct discharge of waste water from paper mills and sugar plants into the lake which has seriously polluted the ecosystem.

- Environmental deterioration in the drainage area has resulted in water and soil erosion, silting-up of the lake, the lowering of the water level, a continuous decline in the storage volume of the lake, and a generally degraded habitat.
- Construction and maintenance of water conservation facilities, such as dam construction, damages the winter habitat of the waterfowl.
- Due to financial difficulties, the input of funds for infrastructural development and protection-related research projects for the reserve has been seriously inadequate.

China's Wetlands - The Future

China hosts some of the world's largest and most diverse wetland resources. It has nearly all the types of wetland as defined by the Ramsar Convention (of which China has been a Member State since 31 July 1992). In collaboration with the World Wide Fund for Nature and the Asian Wetland Bureau (now part of Wetlands International), the Chinese Government has accelerated efforts to formulate the *China Wetland Protection Action Plan.*The Ministry of Forestry has organized training courses for over 50 wetland experts so that a national inventory on wetland resources can be carried out which will document the distribution of China's wetland resources and their major types of wild fauna and flora, hydrology, current uses, and principal threats. This inventory will be of major significance in the formulation and implementation of the *China Wetland Protection Action Plan.*

Case Study 3: Hong Kong

Mai Po Marshes:

Conserving Wetland Biodiversity through Shrimp Farming

By Lew Young, World Wide Fund For Nature (WWF), Hong Kong

Mai Po Marshes - An Introduction

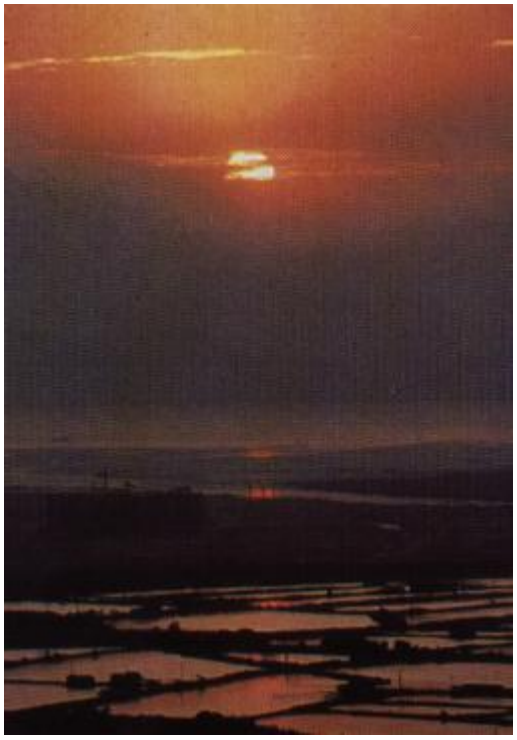
Tucked away in the northwestern corner of Hong Kong, free from urban congestion, is a 2,000ha mosaic of wetlands comprising mudflats, mangroves, reed-beds, traditional intertidal shrimp ponds (*gei wai*) and fish ponds. The 380ha Mai Po Marshes Nature Reserve is at the core of this wetland, being separated from mainland China by the intertidal mudflats of Deep Bay. The Reserve is managed by WWF Hong Kong and administered by the Agriculture and Fisheries Department of the Hong Kong Government. **[Editor's note: The Mai Po Marshes and Inner Deep Bay (a total area of 1,512ha) were designated by the United Kingdom as a Ramsar site on 4 September 1995 and are now one of P.R. China's seven Ramsar sites. 12/97]**

The diversity of wetland around Mai Po has been created by nearly 100 years of land-use changes which have always managed to maintain the 'wet' nature of the landscape. It is probably because of this habitat diversity that the area is so rich in wildlife. Over 320 species of birds have been recorded, including 12 threatened species such as the Black-faced Spoonbill *Platalea minor,* Saunder's Gull *Larus saundersi* and Oriental White Stork *Ciconia boyciana* (IUCN Red List, 1994) as well as regionally important numbers of other species, particularly herons, egrets and certain migratory shorebirds. This area is probably the last stronghold for a number of mammals in Hong Kong, such as the Leopard Cat *Felis bengalensis* and the Otter *Lutra lutra.* Other points of importance include the fact that nearly 20 species of invertebrates new to science have been identified from the wetland system, the mangrove forest is the sixth largest in China and the reed-beds are one of the largest in southern China.

Management of Mai Po - Role of the Gei Wai

The *gei wai* form the heart of Mai Po which, apart from being a source of income for the farmers, are also of high conservation value and are an example of the 'wise use' of a wetland. This is because stocking and feeding of the shrimps is done naturally, and there was minimal destruction of the coastal mangroves when the ponds were constructed in the mid-1940s.

Each of the 10ha rectangular *gei wai* has channels running around its perimeter and across its centre which act as sheltering areas for the shrimps. Between the channels, are stands of mangrove which were originally maintained for fuelwood.



Sunset over the Mai Po Marshes Nature Reserve with Deep Bay mudflats in the background. *(Photo: Lew Young)*

Stocking of the *gei wai* takes place in autumn by flushing shrimp larvae into the pond from Deep Bay through a sluice gate. Once inside, the larvae feed on the detritus and plankton in the pond. By April of the following year, the shrimps are large enough to be harvested, and this is done by opening the sluice gate at night when there is a low tide in Deep Bay. As the water flows out of the pond, a funnel net is placed across the gate to trap any shrimps that are flushed out. On a single night, over 20kg of shrimps can be harvested from a *gei wai* and as only a fraction of the shrimps are caught, it means that each pond can be

harvested many times from April to October when the season ends.

Fish are also cultivated in the *gei wai* since fish fry also enter the pond during stocking. Fish harvesting takes place in late autumn/early winter by draining the pond and then netting the fish trapped in the large pool of water that remains.

The Mai Po *gei wai* represent a type of extensive shrimp farming once common in Asia, but due to intensification of the industry as a result of the increase in demand for shrimps, this method has largely disappeared. Apart from the value of the *gei wai* in conserving wetland biodiversity in Deep Bay, the income generated from the sale of the shrimps and fish provides over 10% of the annual upkeep of the Reserve. The *gei wai* are also an important educational tool, used to demonstrate the value of wetlands to visiting students and members of the public. Regionally, the Mai Po *gei wai* have also been used as an example to promote the conservation of the remaining traditionally operated shrimp ponds elsewhere in Asia, such as in the Red River Delta, Vietnam.

The Biodiversity of Mai Po Marshes

At the time of the draining of the *gei wai* these areas become an important feeding ground for over 500 heron, egrets and spoonbills which are attracted to the small non-commercial fish and shrimps in the shallow pools of water. As each of the Mai Po *gei wai* are drained sequentially, it means that there is a steady supply of food for these waterbirds.

The mangrove and reed-beds inside the *gei wai* are also important wildlife habitats. The mangroves support a diversity of invertebrates under their canopy, such as crabs, gastropods and polychaete worms whilst the canopy itself is a roosting site for many birds, particularly herons and egrets. In the summer, breeding colonies of up to 500 pairs of herons and egrets have formed in the mangroves of a single *gei wai*. The reed-beds support nearly 400 species of invertebrates, and act as a feeding site for migratory birds, such as the Chinese Penduline Tit *Remiz consobrinus,* as well as a breeding site for resident birds, such as the Purple Heron*Ardea purpurea.*

Threats to Mai Po Marshes

The productivity of some of the Mai Po *gei wai* has been seriously affected by organic pollution in Deep Bay, and the affected ponds are now managed solely as wildlife habitats. The Hong Kong Government is cleaning up Deep Bay but this wetland system is now also being threatened by in-filling of the fish ponds outside of Mai Po for development. Whilst there is hope that the adverse effects of these developments can be minimized, there is uncertainty over the area's long-term future in view of its location by an economically expanding part of China. As a result, the full

commitment of the Hong Kong Government and the international community will be essential in conserving this important wetland.

Case Study 4: India

Keoladeo National Park

By Arvinder S. Brar, Department of Environment and Forests, India

General Description

Originally known as 'Ghana', which means 'thicket', and then later as Bharatpur, Keoladeo National Park is a shallow wetland of 2,873ha enclosed by a 2m high stone wall. It lies in a natural depression 172-175m above sea level at the western end of the chain of freshwater wetlands lying along the Indogangetic plains. It is situated 2km southeast of Bharatpur City and 180km south of Delhi.

Keoladeo is flooded during the southwest monsoon (end of June-September) receiving, on average, 660mm rainfall over 32 rainy days. Originally developed as a duck shooting reserve by the Maharajah of Bharatpur in the 1850s, the area was partly man-made with earthen dykes dividing the area into blocks and sluice gates controlling the flow of water to and from the blocks. This system is still in use today. After independence the area was declared a Bird Sanctuary in 1956, although the Maharajah retained the shooting rights for birds and other animals until 1972.

Current Status

The park, a protected forest since its declaration in 1967, was declared a Ramsar site in 1981 in recognition of its value as a unique man-made freshwater wetland which serves as a staging ground for migratory waterfowl and forms an important wintering ground for the threatened Siberian Crane *Grus leucogeranus* (IUCN Red List, 1994). It was included in the list of National Parks in 1982 and declared a World Heritage site in 1985.

The park is surrounded by nine villages with a total population of around 15,000 people who originally depended on the park for fuel, fodder, timber, etc. They ceased to have any rights after the declaration of the National Park.

Biological Diversity

The aquatic vegetation is rich and includes 96 species of submerged and emergent plants as well as a diversity of scrub forests including woodlands, scrub woodlands, woodland savannahs, shrub savannahs, and grass savannahs consisting of various floristic combinations of the following trees and grasses, *Mitragyna parvifolia, Syzygium cumini, Ziziphus mauritiana, Prosopis cineraria, Acacia leucophloea, Acacia nilotica, Capparis sepiaria, Vetiveria zizanioides, Desmostachya bipinnata* and *Cynodon dactylon.* A total of 350 species of plants have been recorded in this small area.

This diversity of plant life supports a high vertebrate diversity including fish (50 species), amphibians (5 species), reptiles (28 species), birds (369 species), and mammals (29 species). Of the bird species present a significant number are considered globally threatened (IUCN Red List, 1994) including Dalmation Pelican *Pelecanus crispus,* Grey Pelican*Pelicanus philippenses,* Adjutant Stork *Leptoptilos dubius,* Lesser Adjutant Stork *Leptoptilos javanicus ,* Baikal Teal *Anas formosa,* Baer's Pochard *Aythya baeri,* Marbled Teal*Marmaronetta angustirostris,* Cinereous Vulture *Aegypius monachus,* Imperial Eagle*Aquila heliaca,* Pallas's Fishing Eagle *Haliaeetus leucoryphus,* Siberian Crane *Grus leucogeranus,* and Sociable Lapwing *Vanellus gregarius*. Threatened mammals recorded within the park include Bengal Fox *Vulpes bengalensis,* Fishing Cat *Prionailurusviverrinus*, and Smooth Indian Otter *Lutra perspicillata* (IUCN Red List, 1994).

Threats and Conservation Efforts

Water is of critical importance for the health of this wetland. Although once a flood prone area, water became scarce after the construction of the Panchna dam in the catchment area and Keoladeo now faces drought, barring years of exceptionally good rainfall. The Rajasthan Government has taken a decision to give the park priority over the irrigation needs of the farmers. Of the two sources of water available to the park, the Yamuna River is not desirable because of the high level of pollutants, and drawing water from the Chambal River involves considerable expenditure since the river is at a lower level than the park and water has to be pumped. Overall, a permanent solution to the water supply problem at Keoladeo is yet to be found.

As the park has become a popular rendezvous for tourists the world over, it attracts more than 100,000 visitors annually. This has encouraged hotel construction around the park which threatens to surround the park from all sides and increase pollution. This can be controlled by enforcing the Environmental Protection Act of 1986 in this area.

The park was originally a major wintering ground of the Siberian Crane *Grus leucogeranus*but their numbers have dwindled over the years. Efforts to conserve the declining population were made

jointly by the Governments of India and the Russian Federation, the International Crane Foundation and the Wildbird Society of Japan. Siberian Crane chicks from two sources, parent reared and costume reared (the latter involved humans disguised as cranes who mimicked the postures used by adult cranes towards their chicks) were flown to India and released in the wild to allow them to integrate with the wild population. Although the non-arrival of wild birds caused an initial setback, the young birds were kept in the park during the summer and the final outcome was encouraging as the birds survived and became free ranging, flying within a radius of 20-30km. Last winter (1995/1996) these birds flew off from the park. There are plans to release more birds and monitor their movements using radiotelemetry.

Paspalum distichum, an amphibious grass which formed a mat in the water areas after grazing was terminated, has been effectively checked by controlling water levels and allowing the villagers to collect grass from the park. However, a study may also be undertaken to investigate the effects of grazing by water buffaloes as a further means of control. *Prosopis juliflora,* an exotic tree species which grows in the park, is controlled by girdling the trees at collar level, extracting the poles manually, and flooding the sapling area with water to check their growth. The Water Hyacinth *Eichhornia crassipes* is extracted manually, and cut-back operations are undertaken to check the sedge *Cyperus alopecuroides*. Khus grass *Vetiveria zizanioides,* which invades water areas during drought periods, is expanding in some areas and various management techniques are used to control this species.

Since the park is surrounded by human populations who once depended on the park, it was felt that their involvement in conservation efforts was important. A detailed Participatory Rural Appraisal was conducted by the World Wild Fund for Nature (WWF) with the cooperation of the Forest Department, Rajasthan. The problems were discussed in villages where at least 50% of the villagers' participation was ensured and solutions were sought from them. A report submitted by WWF is currently being considered by the department. The Park authorities have also employed the local villagers as guides and rickshaw pullers for visitors and as labourers for the management activities within the park.

It is recognized that the education of the villagers with respect to conservation issues and the role of the park is important and a Conservation Education Project is being undertaken around the park by the Bombay Natural History Society, Bombay.

Case Study 5: Japan

Kushiro Marsh

By Hisashi Shinsho, Kushiro City Museum, Japan

Location and Climate

Kushiro Marsh is located in eastern Hokkaido, the northernmost island of Japan's four main islands, and separated from the Pacific Ocean by Kushiro city.

In eastern Hokkaido, especially the Kushiro region, fog often covers the area in summer with the number of foggy days amounting to more than 110 days per year. This area has the smallest number of daylight hours per year in Japan. Climatically, eastern Hokkaido is in the cool temperate zone with an average annual temperature of less than 15.50C (600F). The marsh is of a typical boreal nature in the lowland region of the east coast of Hokkaido.

Covering an area of 18,290ha, the marsh accounts for approximately 60% of the total area of peatlands in Japan. The peat is currently 3-6m in thickness. The marsh is 2-10m above sea level, surrounded by hills which are about 100m above the sea level to the west, north and east. More than 10 tributaries of the Kushiro River meander through the marsh.

The Flora and Fauna of Kushiro Marsh

The marsh is composed of three types of vegetation: peat bog located in the central area; fen, reed and sedge marsh which surrounds the peat bog; and alder swamp forest, distributed on the marsh margins near hills, and the levee areas of rivers and floodplains within the marsh. Fen, reed and sedge marsh forms approximately 70% of the marsh area, where it is a very important habitat of the threatened Red-crested Crane *Grus japonensis* (IUCN Red List, 1994).

The peat bog area, which covers less than 2% of the marsh, is surrounded by several natural river levees so rivers do not overflow into the peat bog and the vegetation is typically boreal. Composed of sterile soil, the peat bog is dominated by *Sphagnum* moss which forms mounds 30-40cm high within which Hair Moss *Polytrichum* sp. and Reindeer Moss*Cladonia* sp. are found. Small shrubs are found within the *Sphagnum* bog such as *Ledum palustre var. nipponicum*, *Chamaedaphne calyculata*, *Empetrum nigrum var. japonicum*,*Andromeda polifolia*, *Vaccinium oxycoccus,Myrica gale var. tomentosa* along with a range of herbs such as Cottongrass *Carex middendorffii, Scirpus hudsoniagus, Schenchzeria palustris, Eleochis japonica, Pogonia japonica*, and insectivorous plants including Sundew Grass *Utricularia intermedia* and *U. uliginaso.*

Bog Rosemary*Andromeda polifolia*, a small shrub found within the *Sphagnum* bogs at the Kushiro Marsh. *(Photo: Hisashi Shinsho)*

Reeds and*Calamagrotis langdorffii* are distributed in the natural levees of rivers, river-flooded plains and the marsh areas close to hills. Sedges are distributed in the remains of old rivers, ponds and peripheral areas of lakes with a high level of groundwater. The sedges *Carex lyngbyei* and *C. rhynchophysa* dominate the marshes near the location where reeds grow in groups, while *C. lasiocarpa var. occultans, C. speudoeuraica* plus *C. limosa* are dominant in the centre of the marsh. In the marsh area which curves into the hills, sedges consisting of *C. caespitosa*and *C. thunbergii* form a tussock grass, growing to a height of 40-50cm and providing a good wintering habitat for insects and amphibians in the marsh.

Alder swamp forest has developed in the basins of the rivers. The swamp forest is supplied with more fertile soil, much nitrogen and phosphorus by water overflowing from the rivers. It consists of only one species, Japanese Alder *Alnus japonica*, which grows in two forms, a tree type measuring 10-11m in height and a shrub type with a height of 2-3m. Both growth forms are regenerated through germination. The distribution and growth of alder is seriously influenced by the conditions within the marsh and this species has proved to be a useful indicator plant for monitoring ecological change.

Kushiro Marsh is one of the most important habitats for boreal wildlife in Japan. Blakiston's Fish-owl *Ketupa blakistoni* and the Red-crested Crane (Japanese populations less than 100 individuals and approximately 600 individuals respectively) both occur in Kushiro Marsh and are threatened species (IUCN Red List, 1994). Research projects on the habitat condition of these species have been carried out by the Environment Agency of Japan.

Kushiro Marsh is the only habitat in Japan of the Siberian Salamander *Salamandrella keyserlingii*. The distribution of this amphibian is restricted to Kushiro Marsh, Siberia, the Kamchatka Peninsula and Sakhalin.

Japanese Hutchen *Hucho perryi* is the largest Japanese freshwater fish and its present distribution is restricted to Hokkaido. Kushiro Marsh is the main habitat for this species which prefers to live in large meandering rivers and lakes where it may grow to more than 2m in length.

A distinguishing characteristic of the marsh is the exceptional abundance of boreal dragonflies. The marsh is one of the very few remaining habitats in Japan where such ancient species of dragonflies, often dating back to the Glacier Age, have been found.

Utilization of Kushiro Marsh

The marsh is of hydrological value in that it controls the water level of the lower course of the Kushiro River and purifies the water which flows through the marsh. It has social and cultural values also in supplying water for domestic and industrial use and providing a breeding habitat for salmon which is one of the most important natural resources in the country.

Located near urban areas, many residents use the marsh for various activities such as research and study, and recreation. Local residents and visitors enjoy various activities such as treks on horseback on the hills facing the marsh, canoeing tours in the rivers of the marsh, cross-country skiing through the marsh in winter, bird-watching and study tours examining the prehistory of the marsh area.

Conservation of Kushiro Marsh

The conservation of Kushiro Marsh is a most important theme because it is the best remaining example of a boreal marsh in Japan. It is also highly regarded because of its vast size, its diversity of flora and fauna including highly specialized, threatened and locally occurring species, and because this fragile ecosystem has remained intact and in a natural state for centuries. Finally, because of its diversity of birdlife it is of international ornithological importance.

In 1987, Kushiro Marsh was designated a National Park to ensure the protection and safety of habitats and the marsh ecosystem. The marsh is also a designated Ramsar site and a National Wildlife Protection Area. In 1995, the citizens of Kushiro city and local people of neighbouring municipalities established the Kushiro International Wetland Centre for several purposes: in order to study wise use management projects being carried out in the marsh; to carry out research into the marsh ecosystem and monitor ecological change in the marsh; and to promote public awareness of marsh conservation and examine the possibility of developing a programme of eco-tours to the marsh. The Centre also contributes to international programmes which promote the conservation and wise use of the marsh. It encourages international collaboration and exchange programmes utilizing the abundant nature and well-equipped facilities available in the Kushiro region.

Case Study 6: Jordan

The Biodiversity of the Azraq Oasis

By Ghaith Fariz and Yassin Al-Zou'bi, Azraq Oasis Conservation Project, Jordan

The Azraq Oasis

Located 85km southeast of Amman near the village of South Azraq, the Azraq Oasis consists of permanent pools surrounded by marsh land (16km2) which in turn is surrounded on all sides, except the west, by mudflat areas (58km2). The large seasonal playa lake in the mudflat, known as Qa Al-Azraq, is flooded during the winter by surface run-off waters flowing through seven wadis over the catchment area of the basin (12,710km2). In 1977, the wetlands of Azraq, which include the pools and marshlands, were listed as a Ramsar site called the Azraq Oasis and the urgent need for their environmental protection has been declared nationally and internationally.

Vegetation

The most recent vegetation survey of the area (February - June 1995), revealed the presence of a total of 133 species of vascular plants within the wetland reserve. Plant distribution varies according to prevailing habitats: the silt dunes are dominated by *Nitraria retusa* and*Tamarix passerinoides* while the rocky limestone areas are dominated by two main species,*Limonium meryeri* and *Inula crithmoides*. Approaching the Qa from the marshes, the leading species consist of *Tamarix passerinoides* and *Halocnemum strobilaceum* until the latter species begins to dominate. Excluding five months in the year (December - April), during which the Qa area is usually flooded, the Qa is barren and lacks any flora except for the clayey border area. These clayey parts are dominated by halophytic plants (those adapted to growing in salt-rich soils) such as *Halopeplis amplexicaulis, Suaeda asphaltica, Tamarix passerinoides* and *Aeluropus littoralis.* Aquatic species that fringe the permanent water bodies consist of lush vegetation stands which include such species as *Typha dominguensis, Phragmites australis, Juncus maritimus*, and *Inula crithmoides*.

Ephemeral water bodies with saline waters are associated with different vegetative associations. In the Azraq wetland these waters are a habitat for *Chara sp., Ruppia cirrhosa, Ruppia maritima, Zannichellia palustris* and *Scripus maritimus* and are fringed by*Tamarix tetragyna, Phragmites australis, Juncus maritimus, Lythrum tribracteatum, Aleuropus littoralis, Halopeplis amplexicaulis.*

The Fauna of the Azraq Oasis

Birds: Being a major station for migrating birds, the Azraq Oasis gains additional national and international importance. Over 250 bird species have been recorded in Azraq with over 200 of these species being migratory. Together with Qa Al-Azraq, the Wetland Reserve used to be an important wintering site for 350,000 - 500,000 waterfowl. These were predominantly three species of duck, Wigeon *Anas penelope*, Teal *A. creca*, and Pintail *A. acuta* and the Coot *Fulica atra* but included a range of other bird species breeding in the area (see Box 6) as well as the threatened Marbled Teal *Marmaronetta angustirostris* (IUCN Red List, 1994), one pair of which was found to breed at the fish pools in 1990.

BOX 6 BIRD SPECIES BREEDING IN THE AZRAQ OASIS	
Water Rail	*Rallus aquaticus*
Little Ringed Plover	*Charadrius dubius*
Greater Sand Plover	*C. leschenaultii*
Spur-winged Plover	*Vanellus spinosus*
White-tailed Plover	*V. leucurus*
Gull-billed Tern	*Sterna nilotica*
Little Tern	*S. albifrons*
Spotted Sandgrouse	*Pterocles senegallus*
Short-toed Lark	*Calandrella brachydactyla*
Lesser Short-toed Lark	*C. rufescens*
Temminck's Horned Lark	*Eremophila bilopha*
Desert Wheatear	*Oenanthe deserti*
Desert Finch	*Rhodopechys obsoleta*

It is believed that the threatened Houbara Bustard *Chlamydotis undulata* (IUCN Red List, 1994), a former resident of the nearby undisturbed areas of the desert to the east of the Qa Al-Azraq area, may occur as a winter resident. The Imperial Eagle *Aquila heliaca* may also be a winter visitor. Regionally threatened or declining species consist of the Bittern *Botaurus stellaris* and Great Snipe *Gallinago media* which is a rare passage migrant. In addition to these species the Azraq Oasis harbours bird species restricted largely to the Middle East. These include the Black-winged Pratincole *Glareola nordmanni,* a rare passage migrant, and Finsch's Wheatear *Oenanthe finschii,* an infrequent winter visitor.

Mammals: Mammals once found in the area include the threatened Grey Wolf *Canis lupus*and Mountain Gazelle *Gazella gazella* (IUCN Red List, 1994) and the Caracal Lynx *Caracal*

caracal. None of these were spotted in the wilderness during the latest survey performed in the area during 1994-95 by the Azraq Oasis Conservation Project.

Fish and Invertebrates: The isolated species of fish and invertebrates in the marshlands are thought to exhibit a high degree of endemism. Since the marshlands have not been previously studied, it has not been possible to detect the effect of habitat degradation on these species. In 1973 one study reported the presence of eight species of molluscs in the reserve's pools and a recent limnological survey of the two permanent pools by the Azraq Oasis Conservation Project revealed the presence of four new species. Two fish surveys carried out in 1973 recorded five species namely: *Aphanius dispar, Tilapia zillii, T. aurea, Clarias lazera* and *Barbus canius,* while another in 1988 found *Clarias gariepinus, Aphanius sirihani, Orechromis aurea* and *Tilapia zillii.* Except for these two major studies, the fish of the Azraq wetlands were not well recorded and attracted little scientific attention until the Azraq Oasis Conservation Project conducted a survey of fish in the wetlands in 1994-1995. Thirteen species were recorded, some of which were new to the records of Azraq and Jordan. *Aphanius sirihani,* which had not been recorded since 1988 and was thought to be extinct, was found during this survey.

Major Threat to the Integrity of the Oasis

Over-pumping of water from the Azraq Basin constitutes the major threat to the natural habitats and biodiversity of the Azraq Wetlands. During the last decade and until the end of 1993, the number of waterfowl declined along with the drying out of the oasis due to the over-pumping of water from the Azraq Basin. By the winter of 1990-91 less than 100 were recorded. An overall collapse of the ecosystems in the area occurred. During 1994 and 1995, as a result of the interventions of the GEF funded Azraq Oasis Conservation Project, huge amounts of water were pumped back into the Oasis. Consequently, larger numbers of various species were sighted again (over 75,000 birds during 1994-95). A more accurate survey of these birds is being undertaken by the Project to determine the impact of intervention.

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Case Study 7: Malaysia

Tasek Bera

By Rebecca D'Cruz, Wetlands International, Malaysia

Major Features of the Wetland

Tasek Bera, Malaysia's first Ramsar site, is one of only two major natural freshwater lake systems in Peninsular Malaysia. The lake, and associated marshes with extensive areas of reeds, freshwater and peat swamp forests, encompass an estimated 6,150ha. The 61,383ha catchment of this swamp lies on the watershed/divide between the west/east coast of Peninsular Malaysia.

There are three major habitat types in Tasek Bera, the first is found in the limnetic or open water region with the aquatic herb *Utricularia* in the surface waters (about 1% of the area), and the second and third within the littoral region, with areas dominated either by *Lepironia*rush and *Pandanus* (about 32% of the area) or by *Eugenia* swamp forest stands (about 67% of the area). The littoral region is thus the dominant feature of this swamp ecosystem, while the limnetic region is restricted to the northern half of the swamp, near the main water channel, the Sungai Bera.

The Many Values of Tasek Bera

Tasek Bera provides a host of important hydrological functions such as flood control, flow regulation, water purification, groundwater recharge and water supply. In addition, the area is important as a prime example of freshwater swamp habitat and blackwater lacustrine ecosystem, supporting a high biodiversity.

The freshwater ecosystem supports a unique biological community including a number of endemic and endangered species. Many endemic plant species have been identified and this includes an aquatic aroid, *Cryptocoryne cordata.* Threatened mammal species that have been recorded in the area include Dhole *Cuon alpinus,* Clouded Leopard *Neofelis nebulosa*, Tiger *Panthera tigris*, Asian Elephant *Elephas maximus,* Malayan Tapir *Tapirus indicus* and Gaur *Bos gaurus* (IUCN Red List, 1994).

The avian fauna is diverse and abundant with about 200 species of birds which include heron, wader and duck species. Two of the species so far recorded are listed as threatened; the Crested Fireback *Lophura ignita* and Masked Finfoot *Heliopais personata* (IUCN Red List, 1994). Four others, the Grey-headed Fish Eagle *Ichthyophaga ichthyaetus*, Black Hornbill *Anthracoceros*

malayanus, Crestless Fireback *Lophura erythropthalma* and Ferruginous Babbler *Trichastoma bicolor*, are considered by some authorities to be near-threatened.

The biodiversity of fish fauna is high with a total of 95 species, representing 22 families. All but one, *Trichogaster pectoralis,* are indigenous to Malaysia and they include two threatened species: Asian Bonytongue *Scleropages formosus* and Ikan Temoleh *Probarbus jullieni* (IUCN Red List, 1994). About 50 species of fish are known as aquarium species, and at least 20 of these are of commercial importance. Sustainable utilization of the fish resources in Tasek Bera for the aquarium trade may be beneficial for both the local and state economies.

Traditional Activities

The indigenous people inhabiting the Tasek Bera area, known as the Semelai, rely on its natural resources. Examples of such resource use are the harvesting of *Pandanus* leaves from the forest to be woven into handicraft items, plants with medicinal values, and 'keruing' oil from the *Dipterocarpus kerrii* tree. The fish and wildlife in the lake and surrounding swamp forest provide a cheap source of protein for the Semelai. Until fairly recently, the Semelai practised shifting cultivation; today about 45% of them work in the adjacent oil palm and rubber plantations.

Semelai woman fishing in the Sungei Bera, the main river flowing into the Tasek Bera system. The lake has a very high diversity of fish which provides a cheap source of protein for local communities.*(Photo: Roger Jaensch/Wetlands International)*

Major Threats

There are a number of major management problems facing Tasek Bera and its catchment. These include increased pesticide/fertilizer run-off from the cash crop plantations surrounding the lake, and pollution from the Bera River-Pahang River and the Palong River-Muar River systems through reverse flow during flood conditions in the northeast monsoon season. There are local reports of declining fish catches and an increase in fish disease as well as marked fluctuations in the water level of the lake during the year. Other environmental impacts may result from clearing of aquatic

vegetation within the lake system for navigational purposes, and increasing levels of harvesting, by non-locals, of food and aquarium fish, plants (especially rattan and tree resins) and other wildlife. In addition, the planned development of nature tourism will give rise to a number of potential threats. There is insufficient cross-sectoral coordination between the agencies responsible for the management of the area and a lack of regular monitoring of the lake water quality.

Status and Management of Tasek Bera

The central core surrounding Tasek Bera, comprising approximately 31,955ha, is currently designated as a Wildlife Reserve, under the Protection of the Wild Life Act 1972, and is administered by the Bera District Office. A large part of the catchment has been converted to oil palm plantation and is under the control of the Federal Land Development Authority. The remaining forested areas exist as five non-contiguous blocks gazetted as Permanent Forest Estates under the jurisdiction of the Forestry Department. Since its acceptance as a Ramsar site, the Pahang State Government has gazetted 26,000ha of the reserve under the National Land Code which allows for the protection of an area for its conservation value. A further 27,500ha in the surrounding area have been gazetted as a buffer zone.

The Ramsar Convention came into force in Malaysia on 10 March 1995. One of the initiatives which has been set in motion since, is the proposed development of an integrated management plan for Tasek Bera, which should serve as a model of sustainable wetland management for other sites in Malaysia. This, coupled with the recently established National Steering Committee for the Ramsar Convention and the proposed development of a National Wetland Policy, clearly indicates a growing recognition of the importance of wetlands in Malaysia.

CHAPTER 5

THE EUROPEAN REGION

An Overview of European Wetlands

By Tim Jones, Technical Officer for Europe, Ramsar Bureau, Switzerland

Boundaries of the Region

Defining the boundaries of Europe is a difficult task and one which is open to a wide variety of geopolitical, biogeographical and other interpretations. Within the framework of the Ramsar Convention, added complexities arise from the fact that several European Contracting Parties have dependent territories in other regions of the world. However, for the purposes of this publication, Europe is considered to include the area from the Atlantic and northern Mediterranean coastlines to the Ural Mountains, the Ural River and the northwest shoreline of the Caspian Sea. Greenland is excluded, but Iceland, Turkey and the trans-Caucasian countries are included. Within this area of approximately 10 million square kilometres - less than 10% of the world's land surface - are crammed no fewer than 48 independent states, as recognized officially by the United Nations (mid-1995).

Thirty-six of these states are Contracting Parties to the Ramsar Convention, with 16 belonging to the Eastern European Ramsar region and 20 to the Western European region. The two regions were established by the Conference of the Parties in 1987 to reflect the political realities at that time. However, European Contracting Parties have decided to maintain the arrangement to reflect ongoing practical and economic differences, even though the political situation has changed completely.

There are more than 550 Ramsar listed sites designated by European Contracting Parties, with about 450 of these being in Western Europe. However, the larger number of sites in Western Europe should be contrasted with the much larger average size of Eastern European sites, reflecting the generally greater extent of wetland loss and fragmentation in the Western European region.

Wetland losses

Europe's long history of settlement, permanent agriculture and industrialization has wrought huge changes on the natural ecosystems of the region and upon the species of flora and fauna which are an integral part of them. Whilst it can be argued that the activities of people gradually increased the biodiversity of Europe over the course of many centuries, through the creation of an intricate, artificial mosaic of habitats, the more recent past has seen a reversal in that trend. Wetlands have come under particular pressure, with the drainage of extensive lowland areas for agriculture and urban development, and the regulation of major river systems for power generation, water storage, navigation and artificial flood control. For example, up to 95% of Switzerland's original marshland has been drained and converted, whilst the Danube and Volga rivers - the two longest in Europe - have been transformed by the construction of numerous dams. In Greece, the construction of dams and drainage tunnels in the late 1940s and 1950s led to the disappearance of 60,000ha of wetlands and the partial drainage of a further 390,000ha. A recent study of 78 major wetlands in France has found that more than 85% of the sites had been significantly or extremely degraded during the period 1960 to 1990. In Poland, less than 10% of the country's once vast peat bogs remain intact, whilst in Bulgaria, of 200,000ha of wetlands at the start of the century, only 11,000 have survived. Increasingly in the 20th century, various forms of pollution (e.g. eutrophication, contamination with heavy metals and radioactive material, acidification, and salinization) threaten the quality of water in wetlands, whilst over-exploitation of groundwater resources in many areas places the very existence of important wetlands at risk.

The Biodiversity of European Wetlands

In spite of the extensive loss and degradation of European wetlands highlighted above, many important wetlands (at international, national and local levels) remain, albeit many of them highly fragmented and much altered in comparison with their original condition. The present-day distribution of wetlands in Europe naturally reflects biogeographical controls such as climate, geology and soil types, but has also been determined by the political and economic differences which have divided the continent for much of the present century.

Taking biogeographical factors first, the variety of European wetlands ranges from coastal lagoons supplied by winter rains in the Mediterranean lowlands, to seasonally frozen Alpine lakes, and from the estuaries of the northwest Atlantic coast to the extensive peat bogs and forested wetlands of Fenno-Scandia and eastern Europe. Central Europe is characterized by lake and river floodplain systems, with seasonally inundated alluvial forests. The northwestern seaboard of the region enjoys the climatic amelioration offered by the North Atlantic Drift Current (or 'Gulf Stream'), whilst the

continental climate of the east European steppe zone gives short, very hot summers and bitterly cold winters.

Turning to anthropogenic factors, wide differences can be seen between western Europe and central/eastern Europe and between northern and southern Europe. In general terms the concentration of economic wealth and highly developed industrialization in north and west Europe has seen the greatest loss, degradation and fragmentation of wetlands. Conversely, in central and eastern Europe, and in Fenno-Scandia, the lower degree of industrialization, urbanization and intensive agriculture means that far more extensive areas of natural or semi-natural wetlands remain. The recent political changes, however, and the further changes which are likely to result in the future - for example, the expansion of industrialized agriculture in the region - place the continued survival of many of these intact (or nearly intact) wetlands in doubt. In the south of Europe, the long history of occupation and often intensive use of Mediterranean wetlands place these areas under special stress, which in many recent years has been exacerbated by low winter rainfall.

In world terms, Europe has a rather small share of global biodiversity, with only about 15% of the total estimated number of animal and higher plant species in existence, reflecting the relatively harsh climatic conditions across most of the region. However, this rather modest diversity forms an important component of the whole, with its own intrinsic value. A typical European, nutrient-rich wetland system could be expected to support a range of simple plants (algae, mosses, etc.), flowering plants, invertebrates, fish, amphibians, reptiles, birds and mammals. Of the animal groups, birds are perhaps the most obvious and best known - a point reflected in the case studies.

The biological productivity of European estuaries is remarkable in global terms, with the constant renewal of nutrients by tidal action supporting phenomenal densities of invertebrates, in turn supporting commercially important fisheries and millions of migratory waterbirds. The Atlantic and North Sea coasts are especially important, with the United Kingdom alone having 163 estuaries.

Like other regions, Europe supports species which are found nowhere else on Earth. Amongst endemic species found at European wetlands of international importance are the fish *Barbus prespensis*, found only at Lake Prespa in Greece. Because of the pressures on natural ecosystems in Europe, a very high proportion of species are considered to be under threat. This is certainly true of wetland species, which depend on habitats which have been highly fragmented and degraded (for example, around a quarter of all fish species and nearly one half of all amphibians in Europe are considered threatened). A recent BirdLife International study of population trends in European bird species concluded that a quarter of all declining species had been adversely affected by wetland drainage. The European Otter (*Lutra lutra*) has been extirpated from much of western and central Europe, whilst intensive agricultural practices mean that many wetland plants (e.g. certain species

of orchids) are becoming more and more confined to nature reserves and other protected areas. In the Netherlands, it has been estimated that 30% of all species require a high water table. However, in many parts of the country, water tables have fallen substantially as a result of groundwater being extracted for use in industry and drinking water supply, and because of more efficient drainage and irrigation.

The Many Values of European Wetlands

Wetlands in Europe, as elsewhere in the world, include highly productive systems, notably estuaries, which provide the plants and invertebrates which form the basis of complex food chains, in which human beings are often the 'top predator'. Wetlands in the region sustain major fisheries and shellfisheries, and provide grazing for livestock. In central and eastern Europe, wetlands continue to provide economically important plant products such as the Common Reed *Phragmites australis* and willow *Salix* spp. which are utilized by local communities.

Europe's wetlands also provide food, shelter and nesting or wintering grounds for millions of migratory birds which undertake seasonal migrations to and from other regions, including Africa, the Middle East, Greenland, Arctic Canada and Siberia. These include true water birds, such as ducks, as well as many other wetland-dependent species, such as Osprey*Pandion haliaetus* and a wide variety of small songbirds. Amongst the many wetlands which are ecologically linked with Europe in this way are two of the sites described in other chapters of this publication: Djoudj National Bird Park in Senegal, West Africa; and the Azraq Oasis in Jordan.

Finally, wetlands play an important role in recreation, be it of an informal kind, or part of the highly developed European tourism and leisure industries. Swimming, sailing, fishing, bird-watching, hiking and hunting are just some of the economically important activities which rely on maintaining a healthy wetland environment.

The Case Studies

The case studies which follow introduce a snapshot of part of the biological diversity and productivity of European wetlands outlined above, as well as illustrating a range of factors which may lead to the loss or degradation of some of this diversity and productivity.

The Ebro Delta in northeast Spain illustrates the diversity of Mediterranean wetland types and species, and the importance of ensuring the conservation and wise use of sites which maintain the ranges of species which have disappeared elsewhere. However, the delta is under pressure from

(amongst other factors) sediment starvation as a result of dam construction upstream, abstraction of river water leading to salinization and eutrophication, pollution by pesticide run-off from intensive agriculture, and tourism development.

The case study chosen to represent the situation in central Europe is the extensive transboundary lake (and other associated wetlands) shared by Austria, where the lake is known as Neusiedlersee, and Hungary, where the name Fertó is used. The site includes a diversity of wetland types, and supports an especially extensive area of reeds which, in turn, support important populations of nesting birds. International restoration measures are currently under way to counter the adverse impacts of the artificial lowering of the water table through past drainage and irrigation.

The extensive peatlands of northern and eastern Europe are represented by Teici and Pelecare Bogs in eastern Latvia. More than 600 higher plant species and 2,800 animal species (including over 2,500 invertebrates) have been identified at the site, which is composed of a mosaic of different wetland habitats. Factors which influence the site adversely include intensive forestry and drainage of surrounding land for agriculture.

The Norfolk and Suffolk Broads case study, from the United Kingdom, is an example of the rich biological diversity and productivity which has arisen in an essentially cultural landscape. The wetland habitats and species now found in the region are the result of centuries of manipulation by local communities for fuel production, wetland plant products, and extensive summer grazing. Maintenance of the area's biological value depends on the continuation of traditional management practices, combined with measures to restore damaged habitats and to counter eutrophication from sewage and agricultural run-off, as well as the effects of mass tourism, and, in the longer term, rising sea levels.

It would have been equally possible to choose many other combinations of case studies to reflect other aspects of the biological diversity and productivity of Europe's wetlands and the challenges which are faced in trying to maintain, and, where necessary, restore these values. For example, estuaries, major river systems, mountain wetlands and Arctic wetlands are not included.

The case studies selected all happen to feature wetlands which are protected areas. However, site protection measures - such as the designation and management of nature reserves - alone, will never succeed in maintaining the biological diversity and productivity of the region's wetlands. They may preserve the 'crown jewels' as living museums, but site-based measures can only be extended to a tiny minority of wetlands. Perhaps the most important task is to ensure that policies dealing specifically with wetlands are incorporated within the general environmental action plans and conservation strategies being drawn up at regional, national and supra-national (e.g. European Union) levels. Conservation and wise use of the vast majority of European wetlands has to be

achieved through wider policies such as integrated planning and management for whole river basins, and adequate consideration of wetland issues by the agricultural, industrial and transportation sectors.

The Role of the Ramsar Convention

The Convention has a long history in Europe, having been initiated largely by European conservationists concerned by the rapid loss of wetlands habitat critical to the survival of migratory waterbirds. Nowadays, Ramsar plays a prominent role at many levels, both within particular states and internationally. Amongst the regional initiatives that the Convention participates in are the Pan-European Biological and Landscape Diversity Strategy established under the ministerial 'Environment for Europe' process, and the 'MedWet' initiative - supported largely by European Union funding - for the conservation and wise use of Mediterranean wetlands.

The Convention aims to maintain close working links with the many national, regional and international organizations - both governmental and non-governmental - active in Europe. Amongst these are the European Commission, Council of Europe, Barcelona Convention, Berne Convention, Bonn Convention (and related Agreements, especially the Agreement on African-Eurasian Migratory Waterbirds), and the regional and country offices of BirdLife International, IUCN-The World Conservation Union, Wetlands International, and World Wide Fund for Nature - WWF.

The Convention has been able to provide - or act as the conduit for - modest funding for wetland projects in countries of central and eastern Europe whose economies are in transition. From 1997 onwards, these states will also have access to the Ramsar Small Grants Fund mechanism; it is hoped that this will ensure ongoing practical assistance for wetland conservation and wise use in the region.

Note: In the European case studies, "Species of European Conservation Concern" refers to BirdLife International's classification of European birds according to their global and European status; it indicates here species with an unfavourable conservation status in Europe (i.e. those in categories 1,2 and 3).

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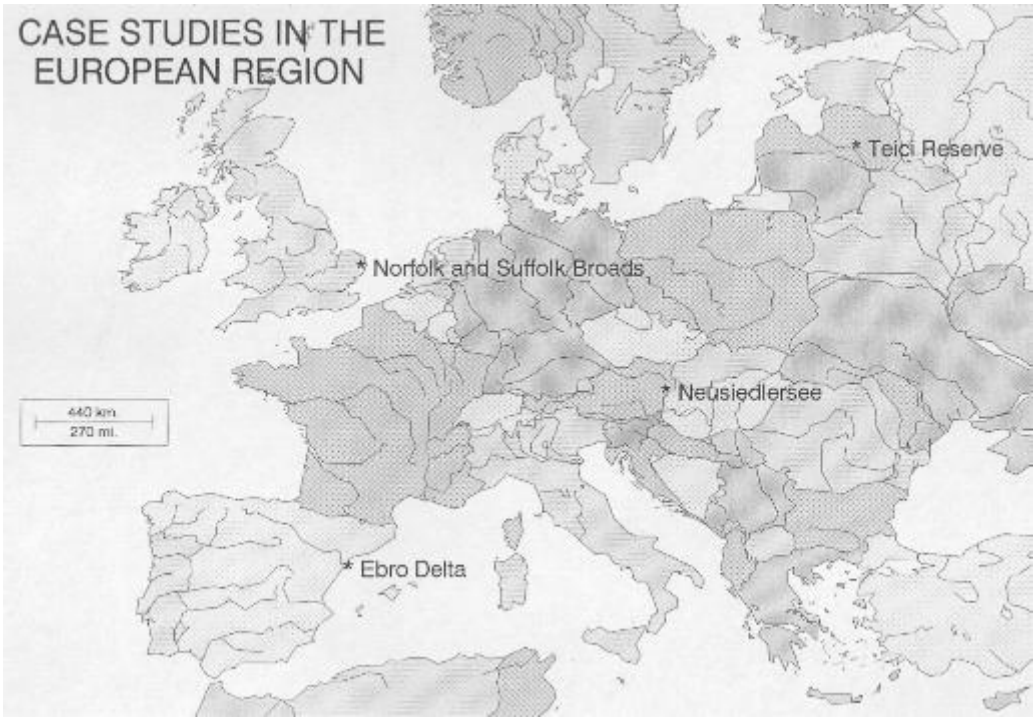

Case Study 1: Austria/Hungary

Neusiedlersee/Fertó

By Gerald Dick, World Wide Fund for Nature (WWF), Austria

General Description

Neusiedlersee is situated at the lowest point of the Little Hungarian Plain and is Europe's westernmost steppe lake. Because of this special situation in terms of biogeographic regions, the biodiversity of the area is characterized by a mosaic of different habitats such as the lake itself, numerous small, shallow alkaline lakes, wet meadows, reed-beds, saltmarsh-like inland vegetation, fen and grasslands. The lake covers an area of 320km2 whereas about 180km2 are covered with the Common Reed *Phragmites australis*. Until the mid-seventies there was a huge belt of

macrophytes in front of the reed (mainly consisting of Fennel Pondweed*Potamogeton pectinatus* and Spiked Milfoil *Myriophyllum spicatum*) which disappeared after the introduction of the alien Grass Carp *Ctenopharyngodon idella*. Right now the plants are slowly recovering due to the natural death of these fish.

Current Status of Neusiedlersee

Various attempts have been undertaken to document the internationally important situation of this wetland site. Under the Bern Convention the site was nominated as a Biogenetic Reserve under the auspices of the Council of Europe. In the framework of the Man and Biosphere Programme, Neusiedlersee was declared a Biosphere Reserve. In 1982 it was declared a Ramsar site and in 1992 a National Park; additionally at the moment it is also proposed as a World Heritage site.

Biological Diversity

The Ramsar site is shared between Austria and Hungary with the greater part, measuring 60,000ha, situated in Austria and the remaining 2,870ha in Hungary. Apart from the strikingly flat landscape which, however, contains diverse ecological units, one mainly thinks in terms of waterbirds when talking about Neusiedlersee. The reed belt, with a maximum width of 12km, holds breeding populations of Purple Heron *Ardea purpurea* (100 pairs), Spoonbill *Platelea leucorodia* (15 pairs), and Bittern *Botaurus stellaris* (200-300 pairs), which are considered Species of European Conservation Concern, as well as a number of other species (see Box 7).

The Seewinkel, east of the lake, is famous for its roosting migratory geese such as the Bean Goose *Anser fabalis* (up to 30,000), Greylag Goose *Anser anser* (up to 6,000) and White-fronted Goose *Anser albifrons* (up to 12,000). It is also noted for the waders breeding and roosting in and at the edge of the small lakes including approximately 100 breeding pairs of Avocet *Recurvirostra avosetta*, 20 pairs of Kentish Plover *Charadrius alexandrinus* and 8 species of breeding gulls and terns. Thirty species of waders and 21 waterfowl species (geese excepted) are frequent migrants, and 13 waterfowl species and Greylag Geese breed regularly.

However, when talking about biodiversity the special situation of the vegetation must also be mentioned. Specialities not only for Austria but even for Europe can be found. *Lepidium cartilagineum* for instance covers an area of distribution as far as from the Ukrainian steppes to its western border at Neusiedlersee. Another rarity is *Artemisia laciniata*, a species of Central Asia which has its only proven locality in Europe at Neusiedlersee.

BOX 7: ADDITIONAL BIRD SPECIES BREEDING AT NEUSIEDLERSEE/FERTÓ		
Great White Egret	*Casmerodius albus*	453 pairs
Moustached Warbler	*Acrocephalus melanopogon*	~ 9,000 pairs
Sedge Warbler	*A. schoenobaenus*	6,000 - 12,000 pairs
Reed Warbler	*A. scirpaceus*	30,000 - 60,000 pairs
Great Reed-Warbler	*A. arundinaceus*	8,000 pairs
Savi's Warbler	*Locustella luscinioides*	3,000 - 5,000 pairs
Bearded Tit	*Panurus biarmicus*	>10,000 pairs
Water Rail	*Rallus aquaticus*	8,000 - 12,000 pairs
Little Crake	*Porzana parva*	4,000 - 6,000 pairs

Wetland Losses and Current Threats

After some glimpses of the jewels of the area some negative factors have to be mentioned. Due to so-called improvement and drainage measures, the water surface of the shallow lakes east of Neusiedlersee diminished from 3,615ha in 1855 to only 805ha in 1986. Also the typical 'puszta' pastures (dry grassland) were changed into arable land. The intensification of agricultural land-use led to extensive eutrophication, easily visible in terms of algal blooms and reed expansion (1,009ha in 1855 versus 3,016ha in 1993) as well as the occurrence of botulism in waterfowl (over 2,000 dead birds in 1982 and again 1983, although in 1992 only 641 carcasses were collected).

Furthermore, groundwater resources are used for irrigation purposes and even maize fields and vineyards are watered. Together with the effect of numerous drainage canals, the lowering of the groundwater level and the decline in salinity pose major threats. The drying out of large lakes and the disappearance altogether of some lakes due to the lack of water is a serious problem. Attempts are now being made to build sluices on the old canals in order to reduce the run-off speed of the water and to restore the water balance. On Neusiedlersee itself attempts have been made to raise the water level because of the effects of an artificial outflow which was built in 1910.

The creation of the transboundary National Park helps to promote wetland restoration and it is hoped that wise use of the whole Ramsar site can be achieved in the near future to maintain and manage the biodiversity and resources of the area.

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Case Study 2: Latvia

The Teici Reserve

By Ugis Bergmanis, Teici State Nature Reserve, Latvia

Location of the Reserve

The Teici Reserve is made up of the Teici and Pelecare Bogs, situated in the eastern part of Latvia within the regions of Madona, Jekabpils and Preili. The total area of the territory covers about 24,000ha, and it was designated as a Ramsar site on 5 April 1995. Both bogs are typical for Eastern Latvia. The Teici Bog has been a State Nature Reserve since 1982 while the much smaller Pelecare Bog has been a restricted Nature Area since 1977.

Management Organization

Most of the area (19,047ha) is included in the Teici State Nature Reserve - one of Latvia's five nature reserves and the largest. The area is administered and managed by the Nature Reserve which has a status of state institution and, since 1994, has been administered by the Ministry of Environmental Protection and Regional Development. The reserve is state owned and is included in the list of specially protected nature territories which cannot be privatized.

High altitude peatland and associated lake at the Teici Reserve, showing typical peatland vegetation.*(Photo: Ugis Bergmanis)*

About 80% of the Teici Reserve is

covered by a high bog in an almost untransformed state. This is the largest high bog in Latvia and one of the largest in Europe. As a result of its characteristics this area is recognized as an IUCN Management Category I: a protected area managed mainly for science or wilderness protection. The reserve area is divided into two zones and in one of these, covering about 4,800ha (25%), no human activities other than those connected with research are permitted. In the remaining area of 14,247ha (75%) some management activities are permitted such as limited regulation of animal numbers and erection of artificial nest platforms for rare bird species; local inhabitants are allowed to continue their traditional activities of gathering firewood and wild berries.

An area of 20,000ha has been established as an outer protection zone around the territory designated as a Ramsar site. To prevent activities which could have a negative effect on the ecosystems of the reserve and to promote nature protection in the outer protected zone, small restricted areas around nest sites of Black Stork *Ciconia nigra* and rare raptor species have been established in this area. Hunting of Black Grouse *Tetrao tetrix*, Capercaillie*Tetrao urogallus* and geese as well as use of pesticides is prohibited. Treaties between private landowners and the Teici Reserve will be concluded in the future concerning the use of land and natural resources. In order to preserve ecosystems in their natural state some regulation of hydrological conditions in ditches flowing out from the bog as well as haymaking on natural meadows is planned.

Ecological Description ofTeici

The reserve is situated in the central part of the East Latvian lowlands, its absolute height lying between 97m and 113.4m. The Teici Bog is located in the mixed forest sub-zone of the temperate forest region. The area is not densely populated with an average density of 4 people per km2.

Most of the territory is covered with bogs (ca 15,257ha or 80%) and although around 95% of these are high bogs there are also small areas of transitional and low bogs in some places. Within the bog ecosystem, 206 bryophyte and 672 vascular plant species have been found. Lakes, morasses and pools of different size are typical of the bog and there are 18 lakes larger than 2ha covering a total area of about 380ha. Around the bogs, different sized forest stands cover an area of about 3,729ha (20%) and mineral soil islands and peninsulas inside the bog are also covered with forests. Some 97% of total forest area is natural forest. The dominant tree species are Scots Pine *Pinus sylvestris* (ca 51%), Silver Birch *Betula pendula* (ca 33%) and Norway Spruce *Picea abies* (ca 12%) mixed with Aspen *Populus tremula* and also Common Alder *Alnus glutinosa,* Common Ash *Fraxinus excelsior* and Small-leaved Lime*Tilia cordata.* These are mainly middle-aged stands. Most widespread are the forests on drained peat soils, dry mineral soils and wet peat soils although there are small areas of forest growing on wet and drained mineral soils.

The diversity of habitats accounts for the considerable diversity of the fauna - 2,837 animal species have been found there. Most of them are invertebrates (2,596 species) with arthropoda the best investigated group (2,553 species). Vertebrates are represented by 41 species of mammals and 186 species of birds. The list of mammal species found here includes several species considered threatened in much of Europe such as the Beaver *Castor fiber*, Lynx *Lynx lynx,* Grey Wolf *Canis lupus*, Brown Bear *Ursus arctos* and Otter *Lutra lutra*. Of the bird species which have either been found nesting or are thought to be nesting, 15 are considered Species of Europe Conservation Concern, including: Black- throated Diver*Gavia arctica* (2-3 pairs); Black Stork *Ciconia nigra* (3-5 pairs); Short-toed Eagle*Circaetus gallicus* (1 pair*);* Lesser Spotted Eagle *Aquila pomarina* (3.5 pairs per 100 km2); Golden Eagle *Aquila chrysaetos* (one probable breeding pair); Peregrine *Falco peregrinus*(one probable breeding pair); Black Grouse *Tetrao tetrix* (common breeding species); Crane *Grus grus* (15-32 pairs); Black- tailed Godwit *Limosa limosa* (8-16 pairs); Wood Sandpiper *Tringa glareola* (48-97 pairs); Nightjar *Caprimulgus europaeus* (breeding); Three-toed Woodpecker *Picoides tridactylus* (breeding); Green Woodpecker *Picus viridis*(breeding); Grey-headed Woodpecker *Picus canus* (breeding); Osprey *Pandion haliaetus* (1-2 pairs). Other important breeding species are listed in Box 8.

BOX 8: ADDITIONAL IMPORTANT BIRD SPECIES BREEDING AT TEICI

Montagu's Harrier	*Circus pygargus*	1-4 pairs
Merlin	*Falco columbarius*	up to 5 pairs
Willow Grouse	*Lagopus lagopus*	some pairs probable
Capercaillie	*Tetrao urogallus*	3 leks with ca 30 males
Golden Plover	*Pluvialis apricaria*	21-78 pairs
Whimbrel	*Numenius phaeopus*	2-21 pairs
Curlew	*Numenius arquata*	5-13 pairs
Ruff	*Philomachus pugnax*	5-20 pairs
Pygmy Owl	*Glaucidium passerinum*	1.1 territories per 100km2
Tengmalm's Owl	*Aegolius funereus*	7.4 territorial males per 100km2
Ural Owl	*Strix uralensis*	2.5 territories per 100km2
White-backed Woodpecker	*Dendrocopus leucotos*	breeding
Black Woodpecker	*Dryocopus martius*	breeding

The Teici Bog and surroundings are also extremely important as stop-over and feeding sites for passage geese and cranes. During the autumn migration period about 1,200 Cranes, 4,000 White-fronted Geese *Anser albifrons* and 4,000 Bean Geese *Anser fabalis* have been observed simultaneously**.**

The Pelecare Bog

Covering an area of 4,546ha, this bog is located to the south of the Teici Bog. A rather high diversity of habitats is also typical for this bog-forest complex. Although this territory has not been so well investigated it seems a very important site for passage Cranes and geese as well as for the protection of bird species typical of bogs.

Threats to the Teici and PelecareBogs

The peripheral part of the Teici Bog is badly affected by the development of surrounding agricultural lands as well as ditches flowing out from the bog. Most affected are moist forest stands where mineralization of their peat soils has transformed growth conditions of the forests; a rather similar situation has been observed on the areas surrounding the Pelecare Bog. As the laws relating to the reserve area do not cover these territories, the forests around the bog are intensively utilized thus altering the habitat and the diversity of species.

Case Study 3: Spain

The Ebro Delta

By Albert Martinez Vilalta, Parc Natural del Delta de L'Ebre, Spain, and Francesc Giró, Department of the Environment of the Generalitat of Catalonia, Spain

General Description

The Ebro Delta is one of the major river deltas of the Mediterranean Basin. It covers an area of 320km2 and consists of a typical delta platform extending 30km into the Mediterranean. The main surface of the delta is covered by agricultural land, and most natural areas are located along the edges, behind large natural beaches and sand dunes. Two sandy lobes extend from the main delta enclosing large bays of shallow water where shellfish production is very high. Natural habitats include also coastal lagoons, salt and freshwater marshes, salt pans, freshwater wells and small remnants of riparian forests. The Ebro Delta is considered of European importance for its saltmarsh

and aquatic vegetation and for its waterbirds, with 40,000 breeding couples and more than 180,000 wintering birds. It is also an important area for fisheries in the western Mediterranean.

Natural water wells at the Ebro Delta - an interesting freshwater habitat typical of Spanish Mediterranean coastal plains close to karstic countryside where underground water overflows. *(Photo: Anna Motis*)

Current Status

At present, the main remaining natural areas covering 7,736ha are protected as a Natural Park and a further 3,794ha are included in the Catalonian Plan of Areas of Natural Interest (PEIN). The Ebro Delta is a Ramsar site and also an Important Bird Area, as identified by BirdLife International. It is also being considered for inclusion in the European Union's Natura 2000 Network of important conservation sites. Within the park, there are 4,400ha where hunting is strictly forbidden and fishing is not permitted in a 900ha sector. The PEIN provides basic protection to some other areas including a buffer zone of rice fields around lagoons. Almost all of the coastal areas are public land while nearly half of the lagoons and marshes are private property. A Zone Plan is being developed to reduce the impact of agriculture in aquatic ecosystems and to guarantee the continuity of rice production in the delta.

Utilization

Because the Ebro Delta is heavily populated compared to other Mediterranean wetlands, the area is intensively utilized. There are very few areas where the natural resources are not exploited. In most of the delta, agriculture is the main activity and this includes intensive rice production covering 21,500ha and in some areas other crops such as lettuce, tomato, and melon. In a couple of relatively small areas, there is some extensive cattle ranching allowing the development of interesting habitats. Fishing is very important both in the lagoons, river and surrounding sea. Shellfish production is also remarkable in the enclosed bays of La Banya and El Fangar. Aquaculture is becoming important in some areas including both extensively and intensively managed systems. Waterfowl hunting is very popular in the area with over 5,000 hunters. Finally, tourism development, concentrated at the moment in the resorts of Riumar and Eucaliptus, is likely to spread to other areas.

Major Threats

The Ebro Delta is a heavily populated area with over 50,000 inhabitants. This, together with the lack of an overall integrated management plan for the whole area, creates a complex situation. The main threats are as follows:

-- subsidence of the delta plain and serious local erosion of the coast due to the almost complete reduction in the sediment loads of the river, retained upstream in dams;

-- river flow has been reduced due to the intensive use of water, mainly in the summer, resulting in salinization and eutrophication. If the proposals of the 'Plan Hidrologico Nacional' go ahead, these reductions could be much worse;

-- heavy water pollution because of intensive agriculture. This is mainly due to the use of pesticides, but also because of nutrients causing eutrophication of some lagoons;

--improvement of the irrigation system by transforming natural ditches into concrete channels and by setting up drainage pumps. This has very negative effects upon the water table and upon fish and invertebrate populations;

-- intensive use of natural resources, leading sometimes to overuse (hunting, fishing, harvesting of natural shellfish stocks);

-- development of the area for tourism. This is already degrading some of the beaches and there are constantly new development proposals;

-- reclamation of natural areas to develop intensive aquaculture projects. This is becoming important in some areas.

Habitats and Species of Particular Interest

Most of the typical Mediterranean wetland habitats are present in the Ebro Delta except for a few types such as riparian forest and certain freshwater temporal marshes. As far as the flora is concerned, the Ebro Delta is a unique site in the Iberian Mediterranean coast. It is an area of great biogeographical interest with many species having their northernmost or southernmost distribution limits (e.g. Honeysuckle *Lonicera biflora*; Tamarisk *Tamarix boveana*, Common Alder *Alnus glutinosa*). There are also many rare species in aquatic habitats such as Pepperwort *Marsilea quadrifolia*, White Water-lily *Nymphaea alba*, and the Lesser Naiad *Najas minor*, while in sandy and saline soils other rarities can be found (e.g. *Limoniastrum monopetalum*, *Loefingia*

hispanica, *Zygophyllum album*, *Orobanche cernua*, and 10 different species of the sea lavender genus *Limonium*).

The delta is well known for its animal life. Among invertebrates, molluscs are particularly rich with endemic snails of the genus *Melanopsis* and the very rare *Margaritifera auricularia*. There are important populations of endemic fishes such as the threatened*Aphanius iberus* (IUCN Red List, 1994) and the Valencia Toothcarp *Valencia hispanica*. There are also some rare reptiles such as the European Pond Terrapin *Emys orbicularis*, the Spanish Terrapin *Mauremys leprosa* and two globally threatened species, Herman's Tortoise *Testudo hermanni* and the Loggerhead *Caretta caretta* (IUCN Red List, 1994). The Loggerhead has occasionally nested on the beaches.

The delta is particularly important for aquatic birds and especially for its nesting populations of gulls and terns. Outstanding is the world's biggest colony of 10,300 pairs of Audouin's Gull,*Larus audouinii*, a threatened species (IUCN Red List, 1994). Other species nesting in large numbers in the area are shown in Box 9.

BOX 9: SPECIES OF WATERFOWL NESTING IN SIGNIFICANT NUMBERS IN THE AREA

Slender-billed Gull	*Larus genei*	600 pairs
Gull-billed Tern*	*Sterna nilotica*	300 pairs
Sandwich Tern*	*Sterna sandvicensis*	1,200 pairs
Common Tern	*Sterna hirundo*	5,500 pairs
Little Tern*	*Sterna albifrons*	650 pairs
Whiskered Tern*	*Chlydonias hybridus*	1,500 pairs
Black-winged Stilt	*Himantopus himantopus*	5,000 pairs
Avocet*	*Recurvirostra avosetta*	550 pairs
Collared Pratincole*	*Glareola pratincola*	80 pairs
Kentish Plover*	*Charadrius alexandrinus*	1,600 pairs
Bittern*	*Botaurus stellaris*	2-4 pairs
Little Bittern*	*Ixobrychus minutus*	>700 pairs
Little Egret	*Egretta garzetta*	1,000 pairs

Cattle Egret	*Bubulcus ibis*	4,000 pairs
Purple Heron*	*Ardea purpurea*	500 pairs
Squacco Heron*	*Ardeola ralloides*	450 pairs
Greater Flamingo*	*Phoenicopterus ruber*	300-1,300 fledgings (breeding since 1992)
Night Heron*	*Nycticorax nycticorax*	160 pairs
(Those marked * are considered Species of European Conservation Concern)		

The delta is also a very important resting, moulting and feeding area for thousands of migratory birds. In the autumn, up to 20,000 herons of different species have been seen, while in the winter peak counts, 100,000 ducks, 20,000 coot and over 30,000 waders are present.

Case Study 4: United Kingdom

Norfolk and Suffolk Broads

By Jane Madgwick, Broads Authority, England

History of the Broads and their Current Status

The Broads is an area where marshes, fens, rivers and lakes intertwine to form a wetland unrivalled elsewhere in Britain. These landscapes have been fashioned by patterns of living and working stretching back over many centuries. In particular the excavation of peat for fuel and the harvest of reed, sedge and marsh hay from the undrained peatlands in the upper and middle valleys have created a great diversity of habitats. The major peat excavations of medieval times have led to the creation of 40 shallow lakes or 'broads', some of which were subsequently connected to the rivers. The river system which is tidal and leads by an estuary to the North Sea, has historically been important for the transport of local goods but in recent decades it has supported a thriving tourist industry based around pleasure boating. Several hundred years ago the majority of the land was reclaimed from the estuary and rivers in the lower valleys. These vast flatlands are maintained by pump drainage and continue to be highly prized summer pastures for cattle and sheep.

The area that receives national protection under the Norfolk and Suffolk Broads Act of 1988 is approximately 303km2 and includes the floodplains and tributaries of three major rivers (the Bure, Yare and Waveney). The Broads Authority, which was established in 1989 to coordinate the management of the area, has duties for nature conservation, public enjoyment and navigation and is the authority responsible for planning. The area includes 27 Sites of Special Scientific Interest

(SSSIs) designated under UK legislation. Together these SSSIs make up approximately 20% of the Broads area. They have recently been made into a single European Union Special Protection Area and a Ramsar site. Prior to this, two separate, smaller Ramsar sites had existed in the Thurne and Bure valleys since 1976. The new designations include many of the freshwater broads, the majority of the calcareous fens and the areas of drained marshland that support the best examples of aquatic communities in the drainage ditches. Most of this area has also been recommended by English Nature for designation as a Special Area for Conservation under the European Union Habitats Directive. Outside of these statutory designations there are numerous nature reserves.

Species and Communities of Interest

The Broads support the largest expanse of species-rich calcareous fen in the UK. Approximately 2,500ha remains as 'open' fen, clear of woodland and a further 3,000ha is carr woodland, the most extensive of its type in the UK. The varied hydrology of the fens and the complex history of exploitation for peat, reed, sedge and marsh hay has led to great habitat heterogeneity. There are 53 plant communities in the open fen and over 250 different plant species including the rare Fen Orchid, *Liparis loeselii.* The fen communities include swamp and sedge beds dominated by Great Fen Sedge *Cladium mariscus*, tall herb fen, and very wet mires with *Sphagnum* mosses. The fens are also nationally important for birds such as the Bittern *Botaurus stellaris*, a Species of European Conservation Concern, and the Marsh Harrier *Circus aeruginosus* and for a large number of invertebrates that are highly specialized to survive in the fen environment.

Almost 40% of the Broads area is drained marshland. These areas are valued for the extensive ditch network which supports a range of aquatic communities including freshwater and brackish types. The marshes are also nationally important for breeding waders such as Snipe *Gallinago gallinago* and wintering birds such as the Bean Goose *Anser fabalis.* Virtually all of the marshland management is supported by the European Union's Environmentally Sensitive Area Scheme (ESA) which enables the traditional practice of extensive summer grazing to continue to the benefit of wildlife and landscape conservation.

Challenges and Strategies

The Broads Authority and English Nature have developed an overall resource profile for the Broads 'Natural Area' which guides the habitat strategies. Appropriate water management is fundamental to all aspects of conservation in the Broads. The three central elements of water management in the Broads are water resources, water quality and flood defence. A major challenge has been to halt and reverse the process of eutrophication in the rivers and broads. Since the middle of this century nutrient enrichment caused by sewage effluent and agricultural run-off has resulted in the near total loss of aquatic life in the rivers and the connected broads. A programme of installation of

phosphorus removal plants is well underway at the key sewage treatment works affecting the area. Fifteen years of research and experimental management has resulted in the development of a set of practical techniques which can together trigger the recovery of aquatic life. Considerable investment is now being put into the restoration of some of the major broads. A few broads which have remained isolated from the pollution sources still support some of the most important examples of aquatic plant communities in the UK including Stonewort *Chara sp.* and Holly-leaved Naiad*Najas marina.*

The Broads is a fragile wetland with intense visitor pressure in the summer.*(Photo: David Burton)*

The majority of the Broads waterways are open to public navigation (approximately 200km) and congestion is a problem in the summer months. There are also conflicts with the erosion of riverside vegetation due to boat wash. The Broads Authority controls boat speed and can limit the disturbance of flora and fauna by boats through the use of zoning arrangements in sensitive areas. The development of less damaging forms of boating is also being encouraged.

The key challenges in the conservation of the fens are the maintenance of the groundwater supply, the prevention of excessive flooding with nutrient rich and brackish water and the restoration of open fen in the neglected areas which have been invaded by willow scrub *Salix*spp. The Broads Authority and English Nature are working together with landowners to devise an overall management strategy for the whole peatland area. An important part of this strategy is to encourage the commercial harvest of reed and sedge dominated communities for thatching. New commercial uses are being developed for fen products that are not suitable for thatching, including harvest for biofuel and the reintroduction of extensive grazing systems.

The whole of the drained marshland is threatened by saltwater flooding due to the deterioration of river walls, increasing storminess in the North Sea and sea level rise. A major flood alleviation strategy is being devised by the National Rivers Authority to safeguard all the interests of the

Broads area for the long term. The ESA scheme for the Broads is being further developed to meet the nature conservation objectives for marsh ditches and bird life.

CHAPTER 6

THE NEOTROPICAL REGION

An Overview of Neotropical Wetlands

By Montserrat Carbonell, Technical Officer for the Neotropics, Ramsar Bureau, Switzerland

Biogeographical and Political Boundaries of the Region

The Ramsar Convention is an intergovernmental treaty, and in setting the northern and southern limits for the region, strict biogeographical considerations have been waived in favour of political reality. Thus, for Ramsar, the Neotropical Region is considered to include all countries and their territories in South and Central America and the Caribbean.

From a biogeographical standpoint the Everglades (USA) should be considered as part of the Neotropics, as should the Mexican territory along the Gulf of Mexico and the Pacific coast, including a portion of Baja California. On the other hand, the central montane areas of Guatemala and Honduras would be excluded, becoming part of the Nearctic, i.e. North America, while Tierra del Fuego (Argentina and Chile) would be included in Antarctica.

Wetland Diversity

In a region over 10,000km long and reaching almost 7,000m above sea level, a great diversity of ecosystems and of flora and fauna can be found. Although some areas as well as certain groups of plants and animals have been studied thoroughly, the Neotropics remain rather poorly known to science. In spite of this, it is estimated that some 30% of all vascular plants in the world (estimated to be around 400,000 species) can be found in the Neotropics, of which, 80,000 are endemic to it. Of a world total of some 175 families of birds - which include approximately 8,600 species - 86 are present in the Neotropics and 31 are endemic to it. In terms of its mammals, 25% of the 1,100 world species are found in this region.

Within this richness, wetland ecosystems are equally varied, both in terms of species diversity and abundance. The range is impressive: from the tropical coral reefs of the Caribbean, to the mangroves and marshes of the Pacific coast of Central America and the deltas of the Orinoco and the Amazon rivers, to the lakes and saltmarshes of the snow-dominated Puna or Altiplano, the geysers of the Andes in central western Argentina and the fjordland of southern Chile.

The size of wetlands in the Neotropical Region vary tremendously:

-- the 691ha Mejía lagoons designated a Ramsar site by the Government of Peru in 1992 and of great importance for both migratory shorebirds and as a water reservoir for small farms nearby;

-- the 10 million hectares of the Llanos of Venezuela, a vast wetland mosaic, with slow-flowing rivers and streams, lakes, ponds, marshes and seasonally inundated grassland and palm savanna;

-- the 280 million hectares of the Cuenca del Plata (Parana and Paraguay river basins) which includes 14 to 25 million hectares of the Pantanal, the largest freshwater marsh in the world;

-- the 700 million hectares of the Amazon River Basin, most of it bordered by the world's largest expanse of tropical forest but including also non-forested areas, extensive floodplains and lake systems. In Case Study 4 Luis G Naranjo gives his account of the diversity of wetlands in Colombian Amazonia.

The wide altitudinal range in the region is reflected in the extreme differences between wetlands, their values and the benefits they can provide. The coastal wetlands of Belize, Guatemala and Honduras, which include mangrove swamps, seagrass beds and coral reefs, are an example of the richest wetland ecosystems in terms of number of species. A detailed description of coral reefs is provided in Case Study 3 by Sue Wells. On the other hand, Lake Titicaca (830,000ha), is the highest navigable lake in the world at 3,800m above sea level, and it supports important populations of most of the waterbird species which are associated with the high Andes as well as a rich and diverse endemic fish fauna, including 14 species of*Orestias*.

A spectacular component of wetland biodiversity in the Neotropics as a region, is the shorebird migration, occurring twice each year (southward around August and northward around February). Millions of individuals of some 40 species travel from their breeding grounds in northern North America along different flyways in search of the rich and highly productive wetlands of the south which will provide them with abundant food during the non-breeding periods of their life cycles.

Large numbers concentrate in wetlands along the coast of the Gulf of Panama, the Pacific coast of Colombia and Peru, and along the Atlantic coasts of Surinam and Brazil. Some travel still further south, such as the Red Knot *Calidris canutus* and the Hudsonian Godwit *Limosa haemastica*, and reach the shores of Tierra del Fuego, where a Ramsar site has recently been declared to protect Bah'a San Sebastián. Roberto Schlatter explores the diversity of Tierra del Fuego in Case Study 2. Other Ramsar sites of special relevance for the conservation of shorebirds include Paracas (Peru), Lagoa do Peixe (Brazil), Coppenamemonding (Surinam) and Laguna Pozuelos (Argentina). The impressive gatherings of migratory shorebirds are testimony to the richness of the wetlands they use and they are important indicator species of the high productivity found there.

Uses and Values of Neotropical Wetlands

The high productivity of the wetlands results in ecosystems which are not only attractive to shorebirds but also have great potential as fish nursery sites and fishing grounds. This has been of great importance to local and regional economies, past and present. Many human cultures developed along the shores of wetlands in the Neotropical Region, as they did in other parts of the world, and benefited from their plants and animals, respected them and in many cases worshipped the gods that lived in them. Throughout the continent, from Alaska to Tierra del Fuego, pre-colonial cultures followed a similar pattern of use of the natural resources, very close to what we know call 'wise use' or 'sustainable use'.

Little is known about the Carib indians who inhabited the Caribbean islands; all Carib cultures were eliminated and in their place appeared the 'creole mestizo', descendants of mixed blood between Carib indians, blacks and whites. The Kuna and Emberá live in houses built on stilts along the Caribbean and Pacific coasts of Panama and Colombia, in the area known as the 'Tapón del Darién' (Darién Bottleneck). The Ashanincas who live between the Ene and Tambo rivers in Brazil, Colombia, Peru and Venezuela, and the Aguarunas in the Marañón river area in Peru, for example, still use the natural resources like their ancestors, in a rotational manner, but are themselves victims of the excessive human exploitation of both forest and wetland natural resources going on in the Amazon today. The Aymara and Quechua, who live in the heights of the Puna, practised rotating agriculture and farming, while the Uros are still mainly fishermen, living in houses built on rafts made of the Totora Reed *Schoenoplectus totora,* in Lake Titicaca. This wetland was a 'cultural refuge' area in times when these communities were forced to contract because of invasion and aggression from other cultures.

Wetlands in this region provide resources and perform functions of great value to human beings. In an area with 13 independent countries and some 3,000 islands, islets or cays, the Caribbean is constantly stricken by tropical storms and hurricanes. Here, coastal wetlands (including mangrove

swamps, coastal marshes, seagrass beds and coral reefs) play an important role in mitigating the negative impact of these natural phenomena. Two of the largest cities in the region, Buenos Aires and Sao Paulo have developed along the Cuenca del Plata, which provides not only water for human use and industry, but abundant fisheries and wildlife resources and transportation. Because of the low gradient of the land the marshes along the rivers function as water reservoirs, protecting these cities, built (unwisely) along the shores of the rivers, from the negative effects of floods. Wetlands perform another quite different function in Costa Rica: on both Caribbean and Pacific coasts, wetlands here attract thousands of tourists each year who come to watch colonies of nesting waterbirds and the arrival of thousands of turtles which lay their eggs in the intertidal zones of their beaches.

Among the many natural resources exploited by man which are generated by wetlands in the Neotropics, are the Cuban Crocodile *Crocodylus rhombifer* in the Ciénaga de Zapata (Cuba) and the Capybara *Hydrochaeris hydrochaeris* in the Llanos of Venezuela, which have been sustainably harvested for several decades now. In contrast, mangrove trees provide timber and tannins throughout their distribution areas, but have seldom been harvested in a sustainable way.

It is important to emphasize that human exploitation of wetlands is not necessarily synonymous with loss of biodiversity: sustainable practices over the centuries have maintained wetland biodiversity. One interesting study on use of wetlands, related in case study 5, documents the role of grazing cattle in maintaining the biodiversity of the seasonal marsh at Palo Verde: removal of grazing cattle resulted in significant losses in biodiversity.

Threats to Neotropical Wetlands

From a global perspective, it could be said that many South American wetlands are still in fairly good condition, in contrast with the highly modified wetlands of Central America and the intensively exploited or altered ones in the Caribbean.

Caribbean wetlands are probably some of the least known, least protected and most threatened wetland types. Threats to the integrity of these fragile wetland ecosystems include: use of mangrove trees for charcoal and tanning; waste-dumping; land reclamation and conversion to shrimp ponds; overfishing; and uncontrolled and inappropriate tourism activities around coral reefs. Excessive erosion, sedimentation, pollution and human disturbance are the result. In addition, coral reefs have been going through a bleaching process for a number of years in the Caribbean, which might be related to the increase of the sea-water temperature. Recent studies indicate that, in some areas, as much as 40% of coral reef cover has been lost due to bleaching and to the negative effects of human activities.

In spite of the many functions performed by these coastal wetlands such as storm and flood mitigation, retention of nutrients, shoreline stabilization, and tourism, and the many products generated such as forestry and wildlife resources, and fisheries, few wetlands in the Caribbean have any sort of protection, let alone management plans within the context of the wise use of water and wetland resources.

The narrow strip of land between South and North America, which constitutes Central America, is divided by its central range of mountains and, although the wetlands of the Pacific and Atlantic slopes have quite distinctive features, they experience similar problems. Wetlands on both sides still support a wide range of uses by local communities, but war in the past decades, deforestation in hills and mountains, unwise agricultural practices including uncontrolled use of dangerous agrochemicals, reclamation of wetlands for agriculture (mainly rice, banana and sugar cane) and other farming activities, are some of the major threats to which these wetlands are exposed. In spite (or because) of the small land surface on which they are found, these wetlands are unique and of great value. Human population - mainly settled in the central highlands - was relatively stable until recent times, and lately, with population growth on the increase, peace settled in the region, and a relative economic stability, most Central American countries are looking at tourism as a new source of income to boost their economies. But tourism, if not strictly controlled and regulated, could damage or even destroy the resource upon which it depends.

South American wetlands share most of the problems with Central America and the Caribbean. However, in a thinly populated continent (where most humans are concentrated in a few, very large cities), but where countries have enormous foreign debts, governments are trying to attract large financial investments and develop liberal economic policies, sometimes putting development and conservation into serious conflict. In most cases development policies do not take wise use of resources into account, and in a continent where many civilizations have used natural resources in a sustainable way for centuries, megaprojects are becoming the major threat to wetlands. A few examples illustrate this: the Yaciretá and Itaipú megadams on the Paraná River have changed the waterflow regime downstream, fish migration has been affected and fish species originally separated geographically are now mixing; the Hidrovía proposal, if carried out, would involve a modification of the Paraguay River to make it navigable upstream at a level where the Pantanal would be altered; the wetlands of the Darién (between Colombia and Panama) will be threatened if the Panamerican highway is constructed; Laguna Colorada in the Puna of Bolivia, one of the most fragile ecosystems of the world, is threatened by a geothermal project if environmental considerations are not taken into account.

Conservation Efforts and Needs

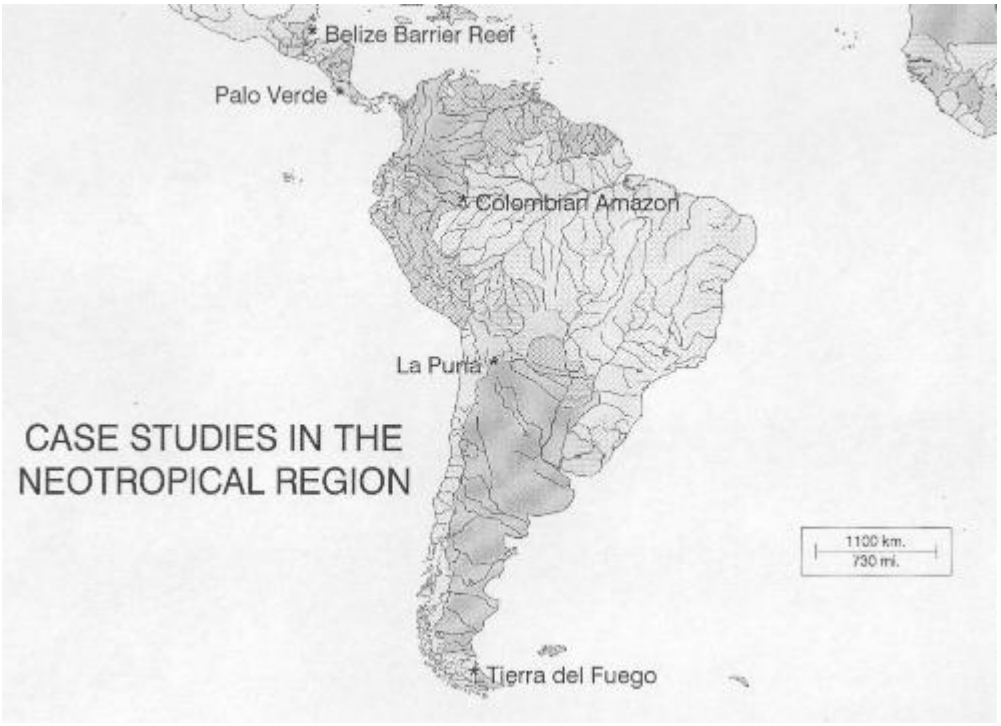
Strong efforts are being made by Neotropical countries to implement their obligations under the Ramsar Convention. However, lack of funding for environmental matters and a general lack of political decision, are making progress slow in most cases. In spite of this, both governmental institutions and NGOs are achieving important results: many countries in the Neotropical Region are developing National Wetland Policies or Strategies in an effort to improve the existing legislation, and Environmental Impact Assessments are already incorporated in the legislation of several countries. A number of National Wetland Committees have been organized to guarantee the participation of all sectors of society (governmental, NGOs and private) on wetland issues and most countries in South and Central America (14 out of 19) have already become Contracting Parties to the Ramsar Convention, a clear sign that the will to change things exists. However, with only 1 Contracting Party out of 13 Caribbean countries, strenuous efforts will be made in the next few years to recruit new members in this part of the region.

Much effort is being directed towards training and capacity building, with local and foreign funding. Many universities, institutes and technical schools are providing degree programmes as well as workshops on wildlife and natural resource management and some have started specific curricula on wetland conservation and wise use.

Management plans are being prepared and implemented at a slow but steady rate. Basic research is badly needed, especially applied research on topics such as harvesting of wildlife and forestry resources. Implementation of management plans is probably the most critical problem when the good will and interest exist but not the economic capacity to carry them out. Some countries, however, have found an alternative solution with governments arranging for NGOs and/or local associations to be responsible for the management of protected wetland sites.

The Future for Neotropical Wetlands

Much remains to be done in wetland conservation and wise use in the Neotropical Region. For this, the highest levels of political and economic decision making must be reached. Environmental agencies within governments, NGOs, universities, as well as indigenous people and local communities are playing an ever increasing role in making this change possible. This is a continent where there is still time to secure natural resources for the benefit of future generations as long as there is a commitment to learn from each others failures and successes.



Case Study 1: Argentina/Bolivia/Chile/Peru

Wetlands of La Puna

By Sandra Caziani, Universidad Nacional de Salta, Argentina

Main Features of La Puna

At an altitude of 3,500 - 4,000m, La Puna or the High Andean Plateau of the Central Andes, is shared by Argentina, Bolivia, Chile and Peru. It is a cold, desert region with intense solar radiation and strong winds which cause extreme temperature variations. There is a dry winter season and average annual temperature and rainfall do not exceed 10°C and 500mm per year respectively.

Three large units can be distinguished altitudinally in La Puna: prepuna, Puna in the strict sense and the high Andean region. The prepuna is dominated by small sparse woods of the column-like cactus 'Cardón' *Trichocereus* sp. and the leguminous tree 'Churqui' *Prosopis ferox*. La Puna is characterized by scrub steppes of grasses and hard-leaf 'Tola' *Parastrephia*sp. and scattered *Polylepis* sp.'Queñoa' forests. In contrast, the high Andean region has largely exposed rocky soils with grasses and cushion plants which are adapted to the dry conditions here.

Many of the rivers flowing to tropical and subtropical forest regions have their sources in these areas, but others form endorreic watersheds (i.e., with no exit to the sea) ending in lakes and 'salares' or salt basins of different sizes. The water volume of rivers and associated lakes varies according to season, with rains and snow melt occurring between October and March (summer). Some lakes are shallow, containing saline and hypersaline water with plankton made up mostly of diatoms. Other deeper and only slightly saline wetlands have abundant submerged vegetation and zooplankton rich in small crustaceans. During the dry season, the natural shrinkage of these wetlands exposes a cover of macrophytes and algae called 'colcha' on which domestic animals feed.

High altitude peatlands or 'bofedales' are found in some areas. Flooded by surface water or by the upwelling of underground fresh water, their vegetation is compact and cushion-like, with grasses, rushes and sedges which remain green almost all year. Behaving rather like gigantic sponges which slowly set water free in the dry season, these areas are very important sources of food for wild and domestic herbivores and they also serve as water reservoirs.

James's Flamingo, an endemic species, feeding at Vilama Lake. *(Photo: Sandra Caziani)*

Fauna Associated with the Wetlands

The threatened Vicuña*Vicugna vicugna*(IUCN Red List, 1994) and the Puna Rhea*Pterocnemia pennata*, which is seen in family groups, graze on the steppes and 'bofedales'. It is also common to observe Andean Condor *Vultur gryphus* feeding on dead llamas. Yet in the middle of this desert landscape, the greatest explosion of life is without a doubt associated with the lakes and 'salares'; the great variety and number of birds, many of them endemic to La Puna, is particularly striking. On the saline lakes, thousands of the endemic James' and Andean Flamingos *Phoenicopterusjamesi* [note: many authorities record this genus as *Pheonicoparrus*] and *P. andinus* can be seen in the water, filtering micro-organisms with their specially adapted bills. They nest in colonies and lay a single egg in nests of mud and gravel. It is common to find large concentrations of Wilson's Phalarope*Steganopus tricolor* feeding near the flamingos. Hundreds of thousands of individuals of this small species migrate every year to the northern regions of North America where they breed. Chilean Flamingo *Phoenicopterus chilensis* is also found in these wetlands, usually together with Horned and Giant Coot *Fulica cornuta* and *F. gigantea* which feed

on the same species of plants they use for building their nests. The latter species is very local and can be found in significant numbers in some of these wetlands, such as Laguna Pululos (Argentina), Lago Me–ique and Lago Miscanti (Chile), Laguna Colorada and Laguna Pelada (Bolivia). Lakes with submerged vegetation support large numbers of waterfowl including Puna Teal *Anas puna*, Crested Duck, *Anas specularoides*, Ferruginous Ruddy Duck *Oxyura jamaicensis ferruginea* and Andean Goose *Chloephaga melanoptera*.

Use and Conservation of the Wetlands

A cultural richness derived from a combination of indian and hispanic elements is typical of this region, as are the houses built of 'adobe'. During the Inca period, human population here was high compared with the sparsely distributed population of today. Extensive farming (camelids and sheep) and mining are now the main activities and although potatoes, corn, and other crops are grown in some areas, it is on a much smaller scale than in prehispanic times; the terraces and irrigation systems used in the past can still be found and in some cases efforts are being made to restore them.

The Spanish invasion dramatically changed the social and trade systems, transforming sedentary farmers into semi-nomadic shepherds and introducing domestic sheep and goats to the llama ranches. Shepherds build 'pircas' (a rock enclosure forming a paddock or corral where pastures are managed) around 'bofedales', to manage the use of these rich pastures by livestock, and these paddocks can be seen scattered throughout the landscape.

At present, animal grazing is associated with the wetland cycle as animals are moved to higher or lower areas to take advantage of the seasonal changes in vegetation growth. For example, the 'colchas' might be used during the winter while the 'bofedales' in higher areas are used in the summer. Unfortunately, little is being done to promote sustainable farming among the inhabitants of the Puna, and overgrazing is contributing to excessive erosion in some areas, especially around wetlands.

Trees and bushes in La Puna continue to be used for fuel in homes and mines, and as material for building enclosures and houses. The light and beautiful wood of the 'cardones' is ideal for furniture and handicrafts. However, the growth of these woody plants is very slow and the loss of vegetation cover due to both cutting and overgrazing increases the erosion of the poorly developed, fragile soil which prevails here.

Severe droughts lasting several years are frequent and cause the disappearance of some of the wetlands and the shrinkage of others. In addition to this natural process, wetlands are facing other threats: siltation, drainage and pollution of the water. Siltation is the result of the accumulation of

sediments carried by the water as part of natural processes and the loss of soil due to human activities (e.g. loss of vegetation cover through firewood collection and overgrazing). Mining and salt extraction (sulphates, borates and others) may contribute to wetland pollution or the loss of wetlands as large amounts of water are used to process the minerals.

Plants and animals are extremely well adapted to the harsh weather conditions found here, and therefore any modification of the ecological characteristics of their fragile environment will mean an almost certain threat to their survival. Most of these negative processes could also adversely affect the rainfall cycle and perhaps reduce the agricultural productivity of the area.

Important wetlands have been or are being designated as Ramsar sites: the Laguna Colorada (Bolivia); the Salar de Surire National Nature Monument and the Lauca National Park (Chile); and the Laguna de Pozuelos National Nature Monument (Ramsar Site and Biosphere Reserve) and Lagunas Vilama and Pululos (Argentina). This is a very important step towards the protection of these rich wetlands since their conservation in the long term depends on the wise use of resources in the basins, including the development of both sustainable farming techniques and alternative means of production for the population in the area.

Case Study 2: Argentina/Chile

Tierra del Fuego

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Early History

Located on the southern tip of South America, Tierra del Fuego extends over 35,000km2 including Isla Grande as well as islands and archipelagos to the south of the Strait of Magellan. The innumerable intermittent columns of smoke and fire which early explorers sighted along the coast gave the area its name, Tierra del Fuego, Land of Fire. The first signs of human life in the region go back to approximately 10,000 B.C. Several indigenous peoples, shared this remote corner of the world:

-- the Haush, who were the most numerous;

-- the Onas (Shelknam), who were the most aggressive and dominant - they were the great hunters of Guanaco *Lama guanicoe* on the steppes of Isla Grande;

-- the Yahganes or Yamanas, who inhabited the far south, living most of the time in canoes;

-- the Alacalufes (Kawaskar) from the northwestern archipelagic region in an area which is now Chilean territory.

Major Features

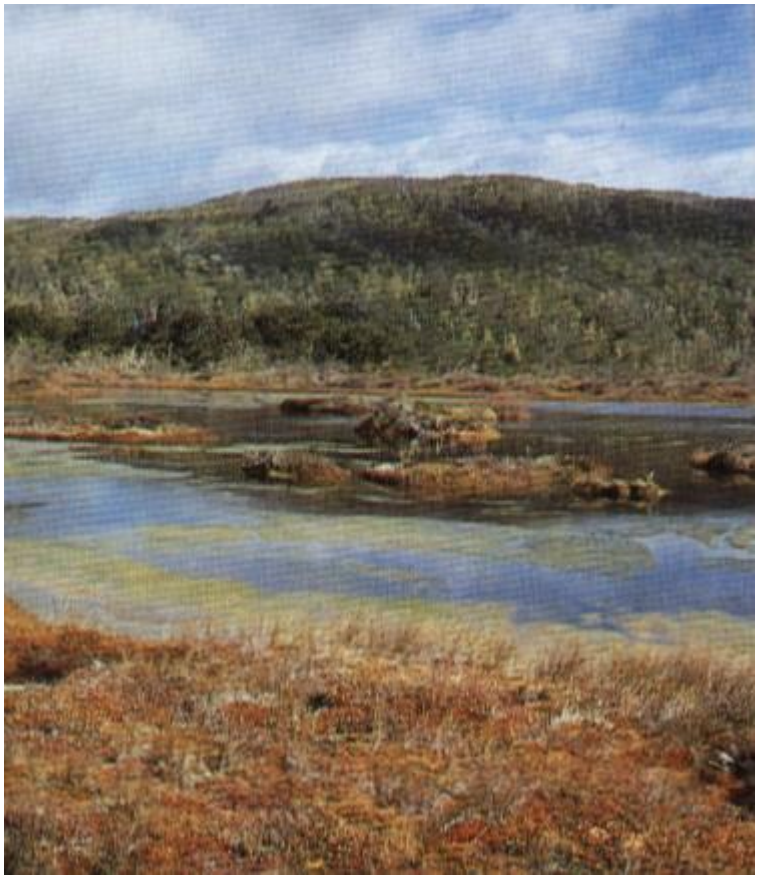
The island is marine in origin from the Tertiary period with a postglacial topography. The layer of volcanic ash and organic soils covering the bedrock measures only 30cm in depth at maximum, resulting in fragile soil conditions. The northern part of the Isla Grande is cold and dry (less than 200mm rainfall annually) and is typically temperate South American grassland with the dominant grasses *Festuca gracillina* and *Chiliotrichium diffusum*. A chain of mountains with deciduous Lenga *Nothofagus pumilo* forests is located to the west and south. Moving further west and south again, there is a rainy zone with perennial subantarctic rain forests where the dominant tree species are Magellan 'Coigue' *Nothofagus betuloides*, along with 'Canelo' *Drimys winteri* and Magellan 'Maitén' *Maytenus magellanica* which are less abundant. In the highlands 'Ñirre' *Nothofagus antarctica* is the dominant species. With rainfall exceeding 7,000 mm per year on occasions, these sometimes form stunted forests.

The Diversity of the Wetlands

Tierra del Fuego has varied and abundant wetlands. The largest catchment area on the island is that of the Río Grande which covers 8,821km2. Its sources of water are Lago Deseado through Río Turba, and Lago Blanco through Río Grande. Inland wetlands include lakes, lagoons and peatlands, and the most important concentration of wetlands is located between San Sebastián (Argentina) and Inœtil (Chile) bays in the northern part of Isla Grande. The largest lake, Lake Fagano or Cami, however, is found towards the southern part of Isla Grande.

Along the coast and in the marine sectors, there are large sandy and stony beaches, numerous fjords, inlets and bays with wetlands which are highly variable in terms of salinity, and with luxuriant algae and peatlands surrounding them. Islands and fjords particularly in the exposed sector possess a large concentration and diversity of marine bird species.

Sphagnum peatlands, dominated by *Sphagnum magellanicum,* are the most extensive wetlands. Peatlands cover approximately one third of the deciduous and perennial forest area and they are essential in maintaining and regulating the drainage of groundwater which originates from rain and melting ice. This is a wetland type of great importance because of its fragility. It is also of importance to local people as it is used as a source of fuel.



A typical landscape in the transitional zone between rain and deciduous forest near Seno Almirantazgo, at 300m above sea level in the Rio Cóndor watershed, Tierra del Fuego. In the foreground is Sphagnum peatland and Nirre forest with some Coigue and Lenga trees. *(Photo: R. P. Schlatter)*.

The richest wetlands in terms of both biomass and number of species (particularly invertebrates and algae) are the coastal wetlands, especially bays and estuaries which abound with bird species such as the Flightless Steamer Duck *Tachyeres pteneres* which feeds on molluscs along the shore; the Kelp Goose *Chloephaga hybrida* which feeds on the extensive Kelp beds; the Southern Giant Petrel *Macronectes giganteus* which lives at sea but comes ashore to feed on dead whales and other carrion. The Magellanic Penguin *Spheniscus magellanicus* nests on the islands of the Strait of Magellan and the Beagle Channel, although none nest on Isla Grande, and it can be regularly seen along the coasts of Tierra del Fuego. The marine otter *Lutra felina,* which once lived in the fjords, and the Southern River Otter*Lutra provocax,* which was found in the rivers of Tierra del Fuego, almost became extinct in the past because of hunting pressure but both species seem to be showing signs of recovery. The Guanaco is still abundant on Isla Grande.

Plant life on the island and archipelagos, numbering some 370 species, is not especially rich in terms of numbers. However, the species involved, their distribution and adaptations to the particularly difficult climatic, hydrological and soil conditions, make this plant life unique.

Threats to the Integrity of Tierra del Fuego

A number of activities within the area pose threats to the wetlands:

-- In the past, fire has been a major problem in Tierra del Fuego together with the conversion of land for grazing. These activities contributed to the extermination of the Onas, Yahganes and Haush Indians and decimated animal species such as the Guanaco.

-- Overstocking, trampling, grazing and wind erosion as a result of sheep and cattle farming have been harmful. Around 50% of the natural prairies are in poor condition as a result of this.

-- Oil drilling in the northeast has an impact, with pollution from oil spills affecting many parts of the Strait of Magellan.

-- Crab harvesting is not only exterminating the resource, but also affecting penguins and dolphins that are caught for use as live crab bait.

-- The introduction of non-native fish species such as Brown Trout *Salmo trutta* and the salmon *Onchorynchus mykiss*, and mammals such as the North American Beaver *Castor canadensis* and Muskrat *Ondatra zibethicus* are a major threat to the few native species adapted to low levels of organic matter in the wetlands.

-- Forestry is beginning to have an effect on river banks, lake shores, peatlands and basins, in the absence of correct environmental planning. Until now, there has been no forest management strategy and in this environment of fragile soils this presents a real threat to ecosystem stability.

Protection of Tierra del Fuego's Biodiversity

On the Chilean side of the Tierra del Fuego much of the animal life and environment are now protected within two of the largest national parks in the country, Cabo de Hornos and Alberto de Agostini, and two Monument Parks, Cisnes Lake and Los Pinguinos while on the Argentinean side the area is protected within the Tierra del Fuego National Park. Argentina has the only Ramsar site in Tierra del Fuego so far, the Reserva Costa Atlántica de Tierra del Fuego which includes Bahía San Sebastián, an important area for shorebirds.

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Case Study 3: Belize

Belize Barrier Reef

By Sue Wells, UNDP/GEF Coastal Zone Management Project, Belize

"The Most Remarkable Reef in the West Indies"

So Charles Darwin referred to the Belize Barrier Reef in 1842, in his study of the origin and evolution of coral reefs. Since then it has become renowned as the largest barrier reef in the Western Hemisphere. Nearly 260km long, it runs from the northern border of the country, where it is only about 1km offshore, south to the Sapodilla Cayes which lie some 40km offshore.

Belize also has one of the most diverse reef ecosystems in the world, with all the main types of reef represented: fringing reefs along the mainland coast; the Barrier Reef itself which grows along the edge of the continental shelf, separated from the mainland by the lagoon; and three offshore atolls (Lighthouse Reef, Turneffe Atoll and Glovers Reef). The presence of atolls is unusual. Most atolls are found in the Pacific, where they form on the top of submerged volcanoes. Very few occur in the Caribbean, and they differ in structure, the three in Belize for example lying on non-volcanic submarine ridges.

The Diversity of Coral Reefs

Of all wetlands, coral reefs are the most diverse, being home to more species than any other marine ecosystem. Only tropical rain forests rank higher on the biodiversity scale. This huge diversity is a result of careful partitioning of the reef by all its inhabitants - some use the reef at different times of day (many reef species are nocturnal), others share it by eating different food. Although reef diversity is much lower in the Caribbean than in the Indo-Pacific (a result of the geological history of the region), over 1,000 species may nevertheless occur on a single reef. Belize has a particularly

high species diversity for the region, with about 65 coral species and over 300 fish species, compared with just over 70 coral species and about 520 fish species in the Caribbean as a whole.

The colourful Queen Angel, one of the 300 fish species recorded at the reef. *(Photo: James Beveridge)*

Fish and invertebrates (notably molluscs, crustaceans, echinoderms and corals) predominate, but algae are also abundant. More species of fish are found on reefs than anywhere else in the sea, ranging from large sharks to tiny gobies. Most species on a reef are in fact never seen by divers and snorkellers as they are tiny, cryptic invertebrates that live in cracks and crevices and can be equated with the insects of the tropical rain forest. It is also likely that about 90% of all reef species, particularly the small invertebrates, are still undiscovered: SCUBA diving equipment was invented less than 50 years ago, and most reefs have only relatively recently become accessible to researchers. New species are being described all the time. For example, an entirely new biodiversity 'hotspot' has been discovered on the Belize Barrier Reef in the last two years in the semi-enclosed lagoons of the Pelican Cayes, a group of mangrove covered cayes. These have startlingly rich, colourful and unusual communities of sponges, corals, and other reef species encrusting the mangrove roots and lagoon sides; in one lagoon, over 40 species of seaquirts (a small, primitive, chordate) have been found.

Reefs also attract large animals such as turtles including the threatened Hawksbill Turtle,*Eretmochelys imbricata* (IUCN Red List, 1994), and seabirds such as the Red-footed Booby*Sula sula* and the Magnificent Frigatebird *Fregata magnificens*, which come to feed on the smaller inhabitants or which depend on the closely associated seagrass beds and mangrove habitats. Although all three wetland types can and do occur independently of each other, in many areas they form an integrated ecological system. Mangroves thrive in calm, turbid, nutrient rich environments, protect reefs from terrestrial sediments and provide shelter among their roots for many juvenile reef species. The seagrass beds stabilize sediments and also provide an important food source for many reef animals. Coral reefs require clear nutrient poor waters, and play an important role in protecting mangroves and seagrasses from erosion during storms and strong wave action. The Belize reef ecosystem illustrates this well, the reef protecting and being linked with

extensive areas of coastal wetlands, lagoons, seagrass beds and mangrove-covered cayes and coastal areas.

Utilization of the Reef

In Belize, the coastal waters were used extensively for fishing by the Mayans between 300 B.C. and 900 A.D. Since early this century, the economic role of the reef has increased steadily with the growth of the coastal population. Initially, its importance lay in the fishing industry, with a wide variety of species being harvested ranging from turtles, sharks and finfish, to sponges and seaweeds. Today, lobster and conch are the principal fisheries products, and contribute most of the total value of exported seafood, estimated at over US$10 million in 1995. There is also a domestic fishery for shallow reef fish and a commercial fishery for groupers *Epinephelus* spp. and snappers *Lutjanus* spp. However, the main use of the Belize Barrier Reef is now tourism, which is the country's largest source of foreign exchange generating an estimated US$75 million in 1994; hundreds of divers visit the reef each year to experience its delights.

Threats to the Reef System

Belize may be one of the last countries in the world to have extensive areas of almost pristine reef but it is also subject to the many threats that are of global concern and which have already seriously degraded an estimated 10% of the earth's coral reefs and currently threaten a much greater percentage. Greatest damage comes from sedimentation, agrochemical run-off, coastal development, tourism and overfishing. Until recently, the main impacts on the Belize Barrier Reef were from natural events such as hurricanes. However, pressures are mounting from a whole range of impacts including escalating residential and hotel development on numerous cayes, the citrus and banana industries which are causing increasing fertilizer run-off, growing numbers of shipping and recreational vessels in the reef-strewn shallow waters, and a steady increase in divers and snorkellers - Hol Chan Marine Reserve alone now receives over 30,000 visitors a year.

Status of Belize Coral Reef

Coral reefs have not yet been used among the primary criteria for listing wetland sites under the Ramsar Convention, although the definition of a wetland allows for their inclusion. Of the 11 Contracting Parties to Ramsar in the Neotropics that have coral reefs, only 3 have listed sites that include these habitats (the Grand Cul de Sac Marin in Guadeloupe, Klein Bonaire Island and adjacent waters in the Netherlands Antilles, and North, Middle and East Caicos Islands in the Turks and Caicos) and in all cases the main interest in these wetlands has been other habitats and waterfowl. Belize is finalising the process for joining Ramsar and, in the first instance, will be

nominating an inland wetland site. However, several parts of the Belize Barrier Reef would qualify for nomination.

A system of marine and coastal protected areas is being set up as part of the Coastal Zone Management Plan that is being prepared for the country. So far there are three protected areas that include reefs: Half Moon Caye Natural Monument on Lighthouse Reef, Hol Chan Marine Reserve on the Barrier Reef, and Glovers Reef Marine Reserve. A number of other areas are likely to be designated as marine reserves or national parks soon, and many of these will be large areas incorporating a range of wetland habitats including the central section of the Barrier Reef, extensive lagoon and saltmarsh areas as well as vast expanses of estuaries, mangroves and fringing reefs.

Case Study 4: Colombia

Forest Wetlands of the Colombian Southern Amazon

By Luis Germán Naranjo, Universidad del Valle, Colombia

Pristine Wetlands

In Colombia, the region called Amazonia comprises nearly one fourth of the national territory. However, its inaccessibility prevented intense colonization until very recently and therefore vast areas still can be considered as pristine. The original habitat included a complex mosaic of vegetation types, whose spatial distribution was largely determined by minor variations in topography and soils. Nonetheless, the dominant habitats in the Colombian Amazon (as well as throughout most of the Amazon Basin) can be described as a vast complex of wetlands. The periodic floods of the Amazon River and its complex network of tributaries determine the existence of a wide array of wetland habitats with a marked seasonal pattern of variation both in the composition of their biotic communities, and in their ecological attributes and functions.

The region around the southern tip of the Colombian Amazon, and the southernmost part of Colombia, is included within the Amacayacu National Park, an area covering 175,000ha. Mean temperature in the area is 260C and annual precipitation near to 2,900mm. The rainfall pattern determines the seasonal pattern with high waters occurring during the first months of the year followed by a period of low waters around June and July. After the 'dry' season, minor fluctuations or 'repiques' occur throughout the area, when the levels of the rivers rise and descend irregularly.

Biodiversity of the Wetlands

Although there is local variation in the composition of plant communities, a generalized succession from wetlands to inland forest for the Colombian Amazon comprises four major stages. In the first place, in the oxbow lakes and swamps, an array of floating plants dominated by the spectacular Regalia Lily *Victoria amazonica,* the largest pond lily in the world, is replaced at the edges by emergent grasses and weeds. At the shoreline the forest begins, dominated by two tree species whose seeds are dispersed by the water. The third vegetation type occurs in small, permanently flooded depressions. It consists of almost pure stands of the palm *Mauritia flexuosa* whose local name 'cananguche' is the source of the term 'cananguchal' applied to this peculiar kind of wetland. Finally, the 'cananguchal' is surrounded by mixed stands of trees of small size, which are exposed to irregular floods when the water level of the rivers becomes exceptionally high.

With such a complexity, the Colombian Amazon wetlands support a highly diverse fauna, varying in composition with the extension and contraction of the flooded areas, and with the structure of the vegetation which fluctuates in response to the hydrologic and climatic regimes. The Colombian Amazon supports about 1,700 species of vertebrates of which the most diverse are freshwater fishes and forest birds, each with about 600 species recorded to date. There are several charismatic mammals dependent on the rivers and adjacent habitats such as the Amazon River Dolphin *Inia geoffrensis*, the Tucuxi *Sotalia fluviatilis*, the Amazonian Manatee *Trichechus inunguis*, and the Great Otter *Pteronura brasiliensis,* all of which are threatened species (IUCN Red List, 1994) and, of course, the Jaguar *Panthera onca*.

Traditional and Future Use of Wetland Resources

It is therefore not surprising that much of this area around the southern tip of the Colombian Amazon is the homeland for about 11 indian tribes which have a long tradition of cultural use dependent on the wetland system. Fortunately, most of their traditions were developed on the basis of a reasonable understanding of the attributes, functions, and values of the wetlands, and therefore the impact of these cultures on the resources of these ecosystem can be considered as almost negligible.

However, the pressure from a growing population of settlers from different regions might represent a potential threat for wetlands and other ecosystems of the Colombian Amazon. Near the Amacayacu National Park, the city of Leticia, capital of the Departamento del Amazonas, remained as a slowly growing settlement for many years after its foundation in 1964. Today, it is one of the most important townships of the entire Colombian Amazon and, despite the relatively small size of its human population (21,868 inhabitants according to the 1993 census), it harbours about 60% of the total population of the Department and has a steady, high rate of annual population increase averaging 3.7%. Although much of the population depends on resources imported from other regions of Colombia and neighbouring Peru and Brazil, the increasing growth of the city still

imposes a heavy toll on natural resources from surrounding areas. In addition, Leticia attracts a significant number of tourists every year, whose activities and impacts should be added to the compounded effect of the development projects throughout the area.

During the last few years, there has been a growing interest within the Colombian government in the Ramsar Convention. If this intention ends in positive results, the list of potential Ramsar sites in the country should include a sample of the extremely diverse Amazonian wetlands. From a local, and a regional point of view, they are unique and have a high value for native cultures besides their importance for the continued existence of several endangered taxa. As a bonus, a more integrated approach to land management practices throughout the region could be implemented and the future development of this small part of the country located in the southern hemisphere could then take place on a sustainable basis.

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Case Study 5: Costa Rica

The Seasonal, Freshwater Marsh at Palo Verde National Park

By Michael B. McCoy, Regional Wildlife Management Program, National University, Costa Rica

Introduction

Recent efforts in the 1980s to preserve two protected tropical wetland ecosystems on opposite sides of the globe, both internationally renowned for their importance to migrating and resident waterfowl, failed to continue to provide the necessary habitat to waterfowl for one simple reason: the forced cessation of cattle grazing of each marsh. In both cases, in a sincere effort to protect a valuable ecosystem, just the opposite effect was achieved. One of these marshes is in Keoladeo

National Park, south of New Delhi, India (see Ali and Vijayan 1986 for a review). The second of these marshes was Palo Verde in Costa Rica, Central America, where the elimination of grazing gave way to a massive invasion of the cattail*Typha dominguensis* with a corresponding drastic decrease in use by waterfowl.

Palo Verde and its Bird Life

The Palo Verde marsh is a 'back marsh' about 5km long and 1km wide running parallel to the Tempisque River and about 20km upstream from this river's mouth at the Gulf of Nicoya, northwestern Guanacaste Province. Strong tidal fluctuations stir up riverbed sediment which is deposited along the bank during dry season high tides. The marsh, isolated from the river by this natural levee, fills to shallow depths of up to 1.25m with rainwater during the wet season. The marsh commences drying in December, and by April is completely dry.

For decades, the marsh was probably the most important wetland area in Central America for about 60 species of resident and migratory waterbirds. In 1979, during a single count in the dry season, it was common to observe up to 35,000 Black-bellied Whistling Ducks*Dendrocygna autumnalis*, 25,000 migratory Blue-winged Teal *Anas discors* and large numbers of other species of migrating ducks such as: Northern Shoveler *Anas clypeata*; American Wigeon *Anas americana*; Ring-necked Duck *Aythya collaris*; and Lesser Scaup*Aythya affinis*. In addition to these migrating birds, up to 500 Muscovy Duck *Cairina moschata*, and several hundreds of wading birds such as Wood Stork *Mycteria americana*, Roseate Spoonbill *Ajaia ajaja*, Great Blue Heron *Ardea herodias*, and up to three or four pairs of Jabiru Stork *Jabiru mycteria* (only 40 individuals remain in Costa Rica), were observed in this marsh in the dry season. In short, the marsh was a paradise of bird and plant diversity. Precisely because of this, the board of directors of the Agrarian Development Institute, after expropriating the cattle ranch within the area, donated the marsh and surrounding forest to the Costa Rican National Parks and Wildlife Service in 1977. This became the first National Wildlife Refuge in Latin America (4,000ha).

Cattle and the Maintenance of Diversity

Traditionally, since at least 1923, the marsh and natural levee (1,000ha) were heavily grazed from November (end of wet season) until March or April by anywhere from 10,000 to 15,000 head of cattle. As the upland areas of this huge ranch dried out and water became scarce, the cattle were brought down to the marsh. This incredibly heavy grazing force (15 cows per hectare) over a period of decades left a very open marsh, with virtually no tall emergent vegetation, but with a diverse flora of about 60 species. During the wet season, large expanses of deeper water were covered by floating vegetation (*Nymphea* sp.) only. The undulating marsh floor created shallower areas where

low-growing sedges *Eleocharis mutata* and small Palo Verde trees *Parkinsonia aculeata* thrived under shorter hydroperiods.

In December, with the onset of strong northeasterly trade winds and the entrance of cattle into the marsh, the floating vegetation was broken up and pushed towards the shallower areas of sedges, thereby creating open water in the deeper pools and channels. As water levels dropped, bands of exposed soil formed between the open water and the shallower sedgebeds. The combination of shallow, open water near to exposed soil was the attractant for the varied bird life that descended upon the marsh at that time.

A Management Problem

In 1980 when Palo Verde became a national park (a category in Costa Rica which does not allow human use), one of the first acts of the new administration of this area was the elimination of cattle from the marsh. From that moment on a rapid transformation of the marsh vegetation was observed. The small patches of cattail that existed in 1980 (covering 40-50ha) were able to capitalize and fill in the void covering 95% of the 500ha marsh by 1988 and preventing the development of the very important interface of 'shallow, open water-exposed soil-sedgebeds' during the dry season; thus the dramatic decrease in waterbird usage in the 1980's, during the dry season concentration. In February of 1988 peaks of only 3,000 Black-bellied Whistling Ducks and 500 Blue-winged Teal were counted and almost no wading birds arrived at all to the marsh.

To make matters worse, the lack of grazing in upland areas created dangerous levels of a tall, fire-loving, non-native species, African Blue-stem Grass *Hyparrhema rufa*. The resulting forest fires entered the marsh during several dry seasons. The flames from the dried cattail leaves wiped out virtually all Palo Verde trees (only nesting sites for six pairs of Everglades Kites *Rostrhamus sociabilis* in 1979) and essentially fertilized new cattail growth upon arrival of the wet season. Almost no other vegetation co-existed in the dense cattail stands that resulted, and much dry forest was also lost in the process.

In other words, the ecosystem's biodiversity was maintained by severe overgrazing, a rather odd consequence. Removal of the grazing effect eliminated the plant and animal biodiversity of the marsh and produced the largest cattail marsh in the region.

Restoration of Palo Verde

In 1987 research began into the restoration of this marsh to conditions similar to that of 1979. After opening up 30ha with underwater mowing to eliminate cattail and underwater cuts at soil level in shallow and deeper water, that all-important interface of 'open, shallow water-exposed soil-low

sedges' formed along the margins in the deeply cut area for the first time in a decade. The response was nothing short of incredible:

- most of the original 60 species of plants came back on their own in treated areas;
- Black-bellied Whistling Ducks peaked at 17,000 and Blue-winged Teal at 4,000 (1990);
- Whistling Ducks, White Ibis *Eudocimus albus* and Glossy Ibis *Plegadis falcinellus*utilized the floating vegetation;
- one pair of nesting Jabiru Storks fed exclusively in this habitat;
- Wood Storks and Roseate Spoonbills utilized the open water area for feeding.

In 1991 complete cattail control was achieved by crushing the cattail stems in the water with a farm tractor. Whistling Duck numbers in 1991 were close to 20,000, and Blue-winged Teal increased even more to 13,000.

Cattle grazing the marsh at Palo Verde and creating waterfowl habitat.*(Photo: Michael McCoy)*

While cattail is now under control, an increase of a tall water grass *Paspalidium* sp. occurred in the mid-depth and shallow water areas after the elimination of cattail which can mask the 'shallow water-exposed soil-sedgebed' interface. Preliminary tests with 30 head of cattle in 30ha has shown potential to control this grass and at the same time provide forage for grazing. The Ramsar Wetland Conservation Fund helped finance the fencing of two 25ha experimental plots in 1994 to test the effect of different grazing intensities on marsh vegetation and waterfowl.

The new Management Plan for the park recognizes the important role of cattle grazing, at least in the dry season. In addition to maintaining a preferred habitat for waterfowl, an economic gain can be made through modest grazing fees, and more importantly, an economic gain can be made by neighbouring, small-scale ranchers. Such a benefit is important from the standpoint of a better identification of the park with the local communities, who in the end will determine the destiny of this area. Effort is underway to organize these ranchers not only to graze the marsh in the dry season but also to graze the upland pasture areas during the wet season, to protect the dry forest, and thus

return to the traditional grazing system that produced one of the most remarkable habitats in Central America.

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CHAPTER 7

THE NORTH AMERICAN REGION

An Overview of North American Wetlands

By Kenneth W. Cox. North American Wetlands Conservation Council (Canada), and Gilberto Cintrón, U.S. Fish and Wildlife Service, United States of America

Extent of North American Wetlands

North America is the third largest continent, covering over 24 million square kilometres; geographically extending from the Arctic Ocean to the warm tropics, the region spans more than 60° of latitude. Canada and the United States occupy much of north central North America, while Mexico extends to its southernmost limit. All three countries are Contracting Parties to the Ramsar Convention.

The North American continent contains a large percentage of all the world's wetlands. These range in size from small, seasonal wetlands (less than a hectare) to vast wetlands spanning immense portions of the landscape. Canada holds about 24% of the world's wetlands, encompassing over 127 million hectares. This is approximately 14% of the entire landscape and about three times the wetland area found in the United States, excluding Alaska.

Wetlands covered 89 million hectares in the United States (excluding Alaska) at the time of the nation's settlement. Today, only 43 million hectares (47%) of the original wetland area remain. In stark contrast, an estimated 81 million hectares of Alaskan wetlands remain mostly undisturbed. In Mexico, wetlands occupy over 2 million hectares, almost two-thirds of these occur on tropical coastlines.

The region has 54 Ramsar sites (Canada 33, United States of America 15 and Mexico 6), amounting to only 7% of Ramsar sites world-wide. However, collectively they cover over 15 million hectares accounting for almost 28% of the total area of Ramsar wetlands, a reflection of the vast size of some of the North American sites.

Wetland Diversity

The large diversity in wetland types reflects the latitudinal span of the North American land mass (from the Arctic to the tropics) and the different climatic conditions, hydrologic regimes, and numerous landscape types found within it.

Extensive Arctic wetlands are found in northern and western Alaska. Most notable are the moist tundra wetlands of the North Slope Coastal Plain, used by Barren Ground Caribou*Rangifer arcticus* for calving and feeding. In Canada, the Arctic wetlands include the sedge meadows of the Athabasca Delta which provide grazing for the world's largest ranging herd of Bison *Bison bison*, and a rich diversity of other mammals such as Grey Wolf *Canis lupus*and Lynx *Lynx canadensis*. In spring and autumn the delta supports over a million birds including many species of ducks, geese and the threatened Whooping Crane *Grus americana* (IUCN Red List, 1994). Other extensive wetlands include the Mackenzie and Yukon river deltas as well as the massive Hudson and James Bay lowlands in the eastern central portion of Canada.

Vast portions of the boreal life zone of North America are dominated by peatlands (bogs and fens). Some 110-130 million hectares of peatlands are found in Canada alone, giving this country the largest peat resources in the world. The bogs and fens of the Boreal region provide seasonal habitat for large mammals, including Woodland Caribou *Rangifer caribou*and Moose *Alces americana*, and many other mammals such as Beaver *Castor canadensis*and Muskrat *Ondatra zibethicus*. The largest concentration of Canadian wetlands are boreal forested peatlands found in the provinces of Manitoba and Ontario, where it is estimated that 22.5 million hectares and 29.2 million hectares of wetlands, respectively, remain.

The wetlands of the Great Lakes and the St. Lawrence Basin consist of bogs, fens, marshes, and forested swamps that are important habitats for migratory waterfowl. The Great Lakes coastal

marshes are connected to the largest reservoir of fresh water on earth (the five lakes have a coastline which exceeds 15,100km and cover an area of 246,568km2). Several wetlands along the Great Lakes in southern Ontario are designated as Ramsar sites. These wetlands provide spawning ground for important freshwater fish species such as Muskellunge *Esox masquinongy*, Largemouth Bass *Micropertus salmoides*, Yellow Perch*Perca flavescens*, and Pumpkinseed *Lepomus gibbosus*. Six species of turtle and several amphibian species are dependent on these habitats. Many thousands of migratory birds, including several duck species, and the Canada Goose *Branta canadensis* use these areas for breeding. Aside from their rich animal and plant diversity, the wetlands also provide many natural products to one of the most populated regions in Canada.

The Canadian provinces of Manitoba, Saskatchewan and Alberta, and the American states of Minnesota, and North and South Dakota, encompass a vast area (780,000km2) where numerous freshwater marshes occupy depressions formed by Pleistocene glaciers. This Prairie Potholes region is the single most important breeding habitat for most North American ducks: approximately 60% of the continent's ducks are raised here, as well as an unknown, but large, proportion of other prairie-dwelling marsh and aquatic birds. The Prairie Potholes region is also a major world producer of cereal grains presenting great challenges to the conservation of these wetlands.

Extensive areas of coastal and estuarine wetlands occur in the North American Region stretching from Atlantic Canada, throughout the entire length of Atlantic U.S. and into coastal lagoons of Mexico's east coast. While not as abundant, Pacific shorelines contain coastal lagoons and river delta wetlands. On Canada's east coast the high tidal amplitudes (to 13m) of the Bay of Fundy have created extensive areas of tidal saltmarsh and intertidal flats that are critically important to international populations of shorebirds. More than 80% of the world population (over 3 million birds) of the Semi-palmated Sandpiper *Calidris pusilla*forage on the tidal mudflats each autumn in preparation for their non-stop flight to Suriname, South America. Four areas of the upper Bay of Fundy have been designated as Ramsar sites. Similarly, the Alaksen Ramsar site on the Fraser River Delta on Canada's west coast supports internationally important shorebird populations in the Pacific flyway.

The extensive coastal plain and abundant rainfall of the southeastern United States supports a complex of large and heterogeneous wetlands that include the Great Dismal Swamp, the Pocosins, and Okeefenokee Swamp. The Great Dismal Swamp covers 850km2 near the Norfolk-Newport News-Virginia Beach urban sprawl. Originally it covered more than 2,000km2; but its area was reduced by draining, logging and fire. Former owners donated 250km2 to the U.S. Government to establish a national wildlife refuge.

The Pocosins are found on the Atlantic Coastal Plain from Virginia to northern Florida; these are wetlands dominated by evergreen shrubs such as *Cyrilla racemiflora*, *Magnolia virginiana*, *Persea*

borbonia, *Ilex glabra*, *Myrica heterophylla*, *Smilax laurifolia* and pine*Pinus serotina*. In North Carolina the Pocosins cover 3,700km2. Okeefenokee Swamp in southeastern Georgia and northeastern Florida is a mosaic of wetlands encompassing 1,750km2. Much of this swamp is now part of the Okeefenokee National Wildlife Refuge, established in 1970.

The southern tip of Florida contains three major wetland types in a 34,000km2 wetland complex: the Everglades, Big Cypress Swamp, and numerous coastal mangroves and glades. Water flows from Lake Okeechobee to the sea as a thin sheet (often centimetres in depth), forming an 80km wide 'sea of grass' dominated by *Cladium jamaicense* (actually a sedge).

Extensive marshes, swamps and shallow coastal lakes exceed 36,000km2 within the Mississippi River Delta. This is a staging and resting area for one of the most important waterfowl flyways in North America. The delta provides habitat for geese, ducks, and American Coot *Fulica americana* and hundreds of thousands of shorebirds that overwinter or pass through on their way to their wintering grounds in Latin America.

Coastal estuarine wetlands are found along the Atlantic, Pacific, Alaskan and Gulf coasts. Saltmarshes are particularly abundant along the Atlantic and Gulf coasts. Mangrove swamps, dominated by halophytic shrubs or trees, are found in southern Florida.

There are more than 125 coastal lagoons along Mexico's Atlantic and Pacific shorelines, encompassing a total surface area of about 12,400km2. Mangroves cover more than 6,500km2, one of the largest areas of mangrove coverage among tropical countries. The 2,970km east coast of Mexico contains some of the largest undisturbed wetland complexes in the Western Hemisphere. Among these are the Laguna Madre, Tampico lagoons and marshes, Laguna Tamiahua, Alvarado lagoons, Tabasco lagoon and marshes and the coastal lagoons of Campeche and Yucatán. The Pacific Coast of Mexico also contains important wintering areas for North American waterfowl.

Threats to North American Wetlands

Historically, conversion of wetlands for agricultural use (drainage) has been the major factor behind wetland decline in Canada, Mexico and the United States. In urban areas filling has accounted for significant wetland losses. Construction of dams, canals, waterways, levees and flood control structures has had serious downstream effects in many places. For example, along the coast of Louisiana, in the United States, more than 100km2 of wetlands are lost annually due to subsidence and erosion as a result of water diversions and sediment deprivation.

In Canada, over one-seventh of the wetland area that existed before European settlement has been converted for other uses. In the United States (excluding Alaska) it is likely that over 50% of the original wetland area has been lost while Mexico's loss is estimated at approximately 35%.

Public awareness and wetland conservation efforts have increased in recent years and new laws stimulating wetland programmes have had positive influences on wetland management. However, it is apparent that the cumulative impact of many small individual actions (no single one of which is alarming) is becoming a major threat to the integrity of wetland landscapes. Unfortunately, no methodology for cumulative impact assessment is universally accepted by scientists and wetland managers.

The North American Waterfowl Management Plan (signed in 1986) is an innovative approach between Canada and the United States to protect and improve waterfowl habitats on a continental scale. In 1994 this plan was revised and Mexico joined the United States and Canada as a signatory. As of April 1995 nearly 810,000ha of wetland habitats have been protected and over a million hectares have been restored or enhanced in North America as a result of the implementation of this plan.

Case Studies of North American Wetlands

The biodiversity of wetland ecosystems in North America is illustrated by the four case studies described in this chapter: Old Crow Flats, Canada; Quill Lakes, Canada; Ría Lagartos, Mexico; and Caddo Lake, United States.

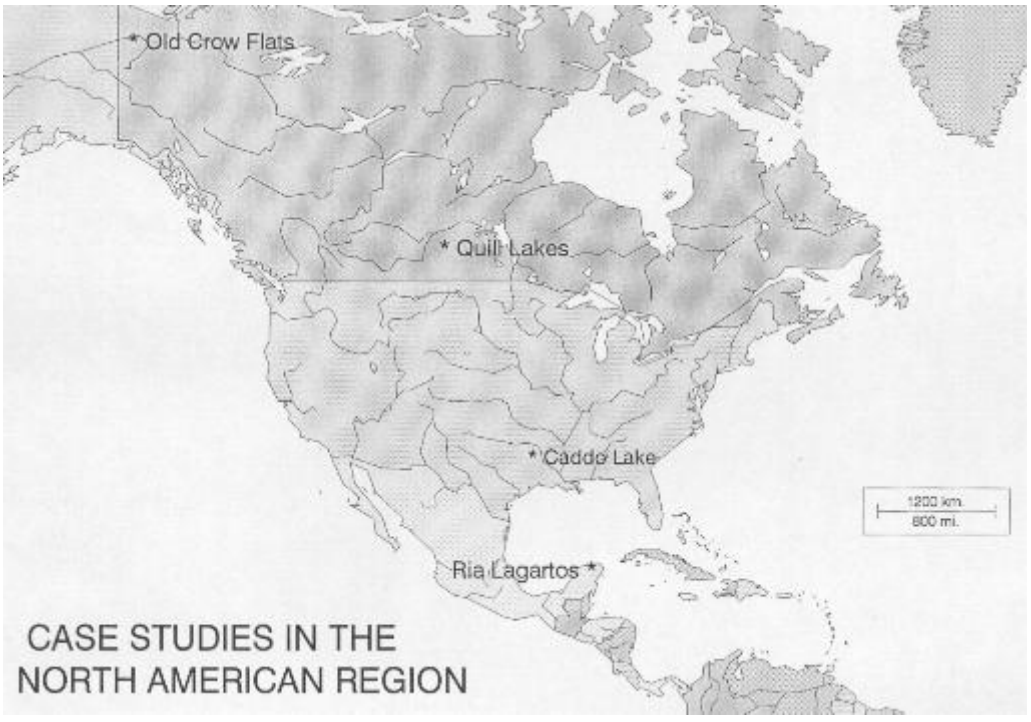
Arctic wetlands include innumerable shallow lakes and ponds that dot the tundra and the marshes during the summer, and shallow-water wetlands along the coasts and in low-lying areas. Old Crow Flats (Case Study 1) is an extensive wetland complex covering the Old Crow River Basin and the Bluefish River Basin in northern Yukon. Over 2,000 wetlands dot the landscape. Low average annual precipitation and average annual daily temperature make this wetland complex unique.

Quill Lakes (Case Study 2) is an exceptionally diverse area that includes two saline lakes, several freshwater marshes, native prairie habitat, and some of the best pothole areas in the Province of Saskatchewan. Every year this area is used by nearly one million birds; it provides excellent habitat for waterfowl as well as a seasonal home for more than 150,000 shorebirds.

In Mexico, much of the Yucatán Peninsula is a calcareous plain with subterranean water courses that surface near the coast and give rise to a series of coastal lagoons and marshes. This chain of saline lagoons and small estuaries along the north shore of the peninsula supports a large breeding

population of Caribbean Flamingos *Phoenicopterus ruber*. Ría Lagartos (Case Study 3) is the largest wetland complex on the east coast of the Yucatán Peninsula, containing two large shallow sea bays fringed by extensive mangrove swamps, studded with numerous mangrove covered islands.

The large shallow wetland which once covered the northern parts of the Mississippi River Basin has long since been drained for agriculture and the basin's most important wetlands are now the lowland floodplains of rivers and streams. Caddo Lake and its associated wetlands (Case Study 4), is one example, hosting wetland forest communities with such species as willow *Salix* spp., aspen *Populus* spp., ash *Fraxinus* spp., elm *Ulmus* spp., and hickory *Carya* spp., in addition to cypress and aquatic communities supporting a range of emergent and submerged aquatic plants. The wetlands of this basin serve as the most important wintering area for ducks and geese in the whole of the central part of the continent and provide staging and resting areas on the most important waterbird flyway in North America.



Case Study 1: Canada

Old Crow Flats, Yukon Territory

By Jim Hawkings, Canadian Wildlife Service, Canada

Major Features of the Wetland

Old Crow Flats, located in the extreme northern Yukon Territory, is a lacustrine plain pocked by over 2,000 wetlands. The wetlands occur in two sub-areas, the Old Crow River Basin, and the Bluefish River Basin. Located north of the community of Old Crow, the Old Crow River Basin is the largest, covering 550,000ha, 26% of which is wetland (open water, emergent vegetation, or floating mats). The Bluefish Basin lies south of Old Crow and covers 83,000ha, 21% of which is wetland. The lakes in the Old Crow Flats vary in size from 0.5 to 4,700ha and have an average depth of 1 to 1.5m and a maximum depth of about 4m. The basin is composed of lacustrine clays deposited during the Quaternary when the basin was flooded by an enormous lake, and overlain by varying depths of organic material which have accumulated since this glacial lake drained about 12,000 years ago. Over the years, streams in the basin have cut deep into the sediments, leaving most of the lakes perched well above the highest spring flood level. The abundant shallow water, 24 hour daylight, and warm summer temperatures make the present lakes exceptionally productive for this latitude.

This image, covering 120km by 120km, was derived from data collected by the Thematic Mapper sensor on the Landsat 5 satellite on 30 June 1990. The Old Crow River Basin covers the upper half, and the Bluefish Basin is the lower right. In this false-colour infrared enhancement, clear water appears as black and turbid water as shades of blue. Note that the large lakes are generally oriented at right angles to the prevailing northeast winds. Dark green tones indicate various types of open canopy spruce forests. The red tones indicate broad-leaved deciduous plants, principally willow, dwarf birch, and various ericacious shrubs. The brightest white and light grey tones indicate barren or sparsely vegetated terrain on mountains surrounding the basins as well as seasonally flooded gravel bars along the rivers. The small community of Old Crow is the only human cultural feature visible. Its airstrip and gravel streets appear as a bright barren area at the confluence of the Porcupine River (draining northeast to southwest across the lower half of the image) and the Old Crow River (meandering northwest to southeast). (*Photo: J. Hawkings)*

The Old Crow Flats constitutes its own ecoregion within the Taiga Cordillera ecozone of Canada. The mean annual precipitation is 200mm, and mean annual daily temperature is -10°C, with July mean daily temperature 15°C and January mean daily temperature -35°C. This makes it one of the

warmest locations in the Yukon in summer and one of the coldest in the winter. The entire area is underlain by permafrost, and growth and decay of ground ice constantly modify the landscape.

The lakes are formed and modified by the combined action of permafrost and the prevailing winds. They appear to go through cycles of draining and refilling, with flushes of productivity at several stages, but the dynamics of this process are not completely understood. Although the lakes are constantly changing in depth and area, this is a gradual process compared to the year to year fluctuations in more temperate or tropical wetlands or in other northern areas subject to seasonal flooding. This makes the Flats a predictable and attractive destination for waterfowl.

Fauna and Flora of Old Crow Flats

Many of the lakes have luxuriant beds of submergent plants such as pondweeds *Potamogeton*spp., burreeds *Sparganium* spp., and even duckweed *Lemna* spp. The terrestrial vegetation is a mixture of shrubs such as willow *Salix* spp., Dwarf Birch *Betula glandulosa*, Labrador Tea *Ledum decumbens*, and lowbush Cranberry *Vaccinium vitis-idaea*, sparse White Spruce*Picea glauca* and Black Spruce *P. mariana* forest with shrub or lichen understorey, and subarctic tundra dominated by Cottongrass *Eriophorum vaginatum* or *Sphagnum* mosses.

More than 100 bird species have been recorded on the Flats, including at least 21 species of waterfowl. The area is important as a breeding and moulting ground to some 500,000 waterfowl including ducks (see Box 10), swans, geese, three species of loon *Gavia* spp. and a variety of other waterbirds. Banding studies have shown these birds to be associated with all four North American Flyways. Waterfowl are more concentrated here than at other locations in the north. For example, densities of ducks on the Flats are usually in the vicinity of 80 ducks per square kilometer, two to three times higher than in any of the 11 primary waterfowl breeding grounds surveyed annually in Alaska by the US Fish and Wildlife Service. Some of these birds breed and moult on the Flats, while others such as Barrow's Goldeneye*Bucephala islandica* do not breed there but come in midsummer from further south to undergo their annual moult.

BOX 10: HIGH NUMBERS OF VARIOUS DUCK SPECIES BREED AT OLD CROW FLATS

According to aerial surveys conducted each June by the US Fish and Wildlife Service, breeding populations over the past 30 years have included:

50,000 - 100,000	Greater and Lesser Scaup	*Aythya marila* and *A.affinis*
20,000 - 100,000	American Wigeon	*Anas americana*
10,000 - 100,000	Northern Pintail	*Anas acuta*

20,000 - 80,000	White-winged and Surf Scoter	*Melanitta fusca* and *M. perspicillata*
5,000 - 40,000	Canvasback	*Aythya valisineria*
10,000 - 30,000	Oldsquaw	*Clangula hyemalis*

The dominant mammal of the Flats is Muskrat *Ondatra zibethicus*, which is present in densities of up to 4.5 per hectare in spring and 9 per hectare in fall, a total population of 330,000 to 650,000. Moose *Alces americana* are also present and, in habitats such as drained lake basins colonized by dense thickets of willow, they are abundant. The Porcupine Caribou *Rangifer tarandus* herd migrates in and around the Flats in spring and fall and some animals are present in the winter. Larger carnivores including Red Fox *Vulpes vulpes*, Wolf *Canis lupis,* and Grizzly Bear *Ursus arctos* are also part of the Old Crow Flats ecosystem.

Traditional Utilization and Management of the Area

The waterfowl, muskrats, and other wildlife of the Flats as well as caribou and salmon are of great importance to the native people of the community of Old Crow, located just south of the Flats at the confluence of the Old Crow and Porcupine rivers. These people are descendants of the first human inhabitants of the area some 20,000 years ago, and are known as the Vuntut Gwitchin, which means 'people of the lakes'.

In 1982 Old Crow Flats was designated a Ramsar site. Under the terms of the Vuntut Gwitchin Final Agreement proclaimed by the Canadian Government in February 1995, the northern portion of the Old Crow Flats becomes Vuntut National Park. Of the remainder, part is Settlement Land belonging to the Vuntut Gwitchin First Nation, and the rest remains federal government land. Despite these three different land tenures, the land claims agreement designates the entire area as Old Crow Flats Special Management Area and stipulates that it be managed to maintain the integrity of the area as one ecological unit, with the conservation of fish and wildlife and their habitats, and the protection of the current and traditional use of the area by the Vuntut Gwitchin as guiding principles. Using these principles, a management plan will be prepared jointly by government and the Vuntut Gwitchin which incorporates the management plan for the Vuntut National Park.

Given the remote wilderness location, pristine conditions, and the strong conservation regime now in place for the Old Crow Flats, its future as a wetland of international importance seems politically assured. One potential threat is global climate change. Old Crow residents seem to feel that lake levels have been dropping, and are concerned that the Flats are 'drying up' from the warmer temperatures and earlier springs of recent years.

Case Study 2: Canada

Quill Lakes

By Saskatchewan Wetland Conservation Corporation, Canada

Location and Major Features

The Quill Lakes contains three distinct wetlands (Big Quill, Middle Quill and Little Quill lakes) and numerous small marshes within a mixed grassland ecosystem. The lakes are located approximately 120km north of Regina, Saskatchewan, the site of the 1987 Ramsar Convention Conference. The area, encompassing over 40,000ha, includes the largest saline lake in Canada, a freshwater lake, several marshes, mixed-grass prairie and aspen parkland. Migratory waterfowl breed, feed and roost on large open marshes adjacent to the lakes as well as on the lakes themselves. Wind action and annual fluctuation in water levels on these shallow lakes create large expanses of fresh mudflats (similar to tide action) used by shorebirds for feeding. The region is considered one of North America's most critical inland waterbodies for up to one million birds.

Typical freshwater marshes located adjacent to Quill Lakes. ***(Photo: Saskatchewan Wetland Conservation Corporation)***

Regional and International Importance

Selected as a Ramsar site in 1987, Quill Lakes was the first implementation site for the North American Waterfowl Management Plan in Canada. As a 'first-step' initiative, nearly 7,000ha were developed or enhanced for waterfowl and other wildlife. Designation as a premier marsh under the Provincial Heritage Marsh Program involved intensified management of existing Ducks Unlimited Canada projects on tributary drainage.

The area was designated as a Western Hemisphere Shorebird Reserve Network site in 1994 - one of only three such sites in Canada. Membership in this Network brings additional international recognition to the Quill Lakes site, enhancing the capacity for conservation.

Species of Significance at Quill Lakes

The Quill Lakes region is a significant North American site for ducks, geese and shorebirds. Shorebird numbers peak in May and late July or early August; ducks and geese in September and October. The important roles played by Quill Lakes include:

-- major staging area for up to 500,000 ducks (primarily Mallard *Anas platyrhynchos*, and others including Pintail *Anas acuta*, Gadwall *Anas strepera*, Redhead *Aythya americana*, Canvasback *Aythya valisineria* and Scaup *Aythya affinis*);

-- major staging area for 250,000 geese (Snow Goose *Anser caerulescens* [or*Chen caerulescens*], Canada Goose *Branta canadensis* and White-fronted Goose *Anser albifrons*), and 40,000 Sandhill Cranes *Grus canadensis*;

-- nesting site for 400 - 500 White Pelicans *Pelecanus erythrorhynchos* (at Middle Quill Lakes);

-- up to 150,000 Arctic-nesting shorebirds have been observed in a single-day count (in 1993) including over 30 different species. The most common migratory visitors include Red-necked Phalarope *Phalaropus lobatus*, Semi-palmated Sandpipers *Calidris pusilla*, Sanderling *Calidris alba* and Stilt Sandpiper *Micropalama himantopus* [or *Calidris himantopus*],

-- breeding site for up to 300 Piping Plover *Charadrius melodus*, a threatened species (IUCN Red List, 1994);

-- habitat for several other threatened and endangered species, including the Whooping Crane *Grus americana* (IUCN Red List, 1994), Baird's Sparrow*Ammodramus bairdii*, Ferruginous Hawk *Buteo regalis* and Peregrine Falcon*Falco peregrinus*.

Threats and Management Solutions

The Quill Lakes region is classified as a saline lowland range. Natural fluctuation in water levels and potential long-term decline in water level on the lakes pose the largest threat. Up until recent years, cattle grazed in many upland areas associated with the lakes, and had access to shorelines, beaches and mudflats which resulted in the destruction of critical habitat for wildlife. Uneven cattle distribution contributed to increased grazing pressure near water sources, and the saline environment appeared to be responsible for patchy cover in several locations.

To address these concerns, waterfowl management plans were developed to guide conservation partners in restoring and protecting areas. The plans feature sound land-use initiatives that

contribute to soil, water and wildlife conservation. A shorebird habitat management plan is in the final stages of preparation. By working with local landowners, who are primarily cattle producers, the Saskatchewan Wetland Conservation Corporation and its partners ensure that producers' needs are taken into consideration at the planning and implementation stage, and that the area is restored and enhanced in a mutually beneficial manner for both wildlife and cattle producers.

It is recognized that the support and participation of local landowners and farmers is crucial to the success of the project. Many of the solutions to prairie soil conservation problems also apply to increasing waterfowl populations. To be acceptable, solutions must be sound from a conservation perspective, and economically fair to landowners and producers in the Quill Lakes area.

Elements of the waterfowl management plan include a Waterfowl Crop Damage Control Program, the acquisition of 12,141ha of land around the Quill Lakes and the construction of fences to reduce conflict between cattle and nesting birds, particularly on the beaches of Big Quill Lake where 19% of the provincial population and 5% of the world's Piping Plover population nest. Managed grazing systems, incorporating rest-rotational and deferred grazing applications, are being implemented by local landowners to ensure that paddocks within the pastures will not be grazed until the nesting season is over. At least one paddock per pasture will not be grazed each year.

Mutual Benefits

Managing pastures will benefit producers by improving range conditions and vegetative cover thus ensuring a sustainable supply of forage for cattle. Increased vegetation will benefit wildlife by improving nesting habitat for grassland nesting birds. The Quill Lakes project will also provide a unique economic opportunity for local individuals to capitalize on developing and marketing products which cater to segments of the burgeoning eco-tourism industry. Nature tourism is one of North America's fastest growing industries and holds a great deal of potential for increased economic development activity in rural Saskatchewan in addition to the economic impact of waterfowl hunting in many communities.

Case Study 3: Mexico

Ría Lagartos, Yucatán

By Mauricio Cervantes, Wetlands International, Mexico

Major Features

The Ría Lagartos estuary is located 270km from Mérida, the capital of the province on the northeast coast of the state of Yucatán. It has a surface area of 55,350ha and extends along 74km of coastline. The north border is formed by a sand bar island with three connections to the sea. The system is composed of three water bodies differing in length from 0.25 to 3.5km. The estuary extends over an area of 9,467ha and the depth varies from 0.5 to 3m. The climate varies from the very dry arid to the very dry warm-humid and the area is located in the path of Caribbean hurricanes. The whole area is a relatively flat land supporting an interesting range of plants and animals associated with coastal ecosystems.

The area is also of archaeological interest: during the Maya civilization this area, previously part of the Chikinchel province, controlled the production of salt for the entire nation. Salt production is still an important source of income along with fisheries for the 1,500 families in the four villages nearby.

Flora and Fauna of the Area

The main flora associations in the Ría Lagartos include:

-- the vegetation of the coastal dunes, composed mainly of xerophitic plants such as Nakax Palms *Cocotrinax readii*, Chit *Thrinax radiata*, and the Kuká Palm *Pseudophoenix sargentii* (these three species are considered as threatened in Mexico);

-- the mangroves, composed of *Rhizophora mangle, Languncularia racemosa, Avicennia germinans* and *Conocarpus erectus;*

-- the tropical xeric (dry) forest running parallel to the coast, composed of*Pseudophoenix sargenti* and cacti;

-- the marsh association which is widely distributed, with the association of*Phragmites australis, Caldium jamaicensis, Typha* spp. being dominant;

-- the 'petenes' - islands of tall forest of several species growing in concentric rings forming a dome . From the centre to the edge of the dome the tree species include *Metopium, Ficus, Plumeria, Manilkara, Thrinax, Sabal and Haematoxylon campechianum.*

The fauna includes 391 species of vertebrates, of which 142 are endemic to Mesoamerica (Central America and Mexico), 15 endemic to Mexico and 1 endemic to Yucatán. Thirty three of these vertebrates, including species of birds, mammals and reptiles, are considered threatened in Mexico.

The Greater Flamingo, which breeds here, is the symbol of the Ría Lagartos reserve. *(Photo: Mauricio Cervantes)*

The area is considered outstanding for birds, with a total of 72 migratory and 141 resident species. The symbol of the reserve is the Greater Flamingo*Phoenicopterus ruber ruber* and the area is an important nesting site for this species. There are 50 species of reptiles, including the snakes *Aqkistrodon bilineatus* and *Boa constrictor.* Four species of marine turtle lay their eggs on the beaches, Hawksbill Turtle *Eretmochelys imbricata*, Green Turtle *Chelonia mydas*, Loggerhead *Caretta caretta*, and Leatherback *Dermochelys coriacea*; all are threatened species (IUCN Red List, 1994). A wide variety of fish inhabit the 'cenotes' of the reserve (depressions in the ground which retain water even when the rest of the wetland has a low water level) including two endemic species, *Typhliasina pearsei* and *Ophisthernon infernale.*

Main Threats to the Area

The main natural threat confronting both the reserve and the local population is the risk of flooding through waves and surge tides produced by hurricanes and storms in the Gulf of Mexico. In 1988, hurricane Gilberto broke the sand bar and the damage inflicted on the area prompted the Mexican Government to request that the Ría Lagartos be included on the Montreux Record. Although sites are usually placed on the Record because of undesirable ecological changes resulting from human rather than natural causes, this request was granted. In 1993 the Mexican Government requested that the site be retained on the Montreux Record because of a number of new activities in the area which threatened the integrity of the ecosystem including salt extraction and illegal fishing and farming. A management plan has been prepared and with partial funding from the Global Environment Facility it is beginning to be implemented. It is hoped that this will eventually lead to the removal of Ría Lagartos from the Montreux Record.

Current Status and Future Management

In 1979 Ría Lagartos was given legal protection mainly to safeguard the colony of the Greater Flamingo and in 1986 it was designated a Ramsar site. In 1988 it was re-categorized as a Biosphere Reserve within the framework of the Man and the Biosphere Programme. A corridor has been established along the coast of the state linking Ría Lagartos with another three reserves and there are plans to extend this corridor along the whole peninsula of Yucatán.

Recently, three more Mexican wetland areas have been designated Ramsar sites. A National Wetlands Programme is being implemented, with the objective of meeting the challenges of sustainable development, conservation and adequate management of the natural resources of the wetlands in the country.

Case Study 4: United States of America

Caddo Lake

By Dwight K. Shellman, Jr. and Roy G. Darville, Caddo Lake Institute, Inc., USA.

The Cypress Valley Watershed occupies approximately 17,400km2 in all or part of eleven Texas counties and one Louisiana parish. Caddo Lake, lying 240km east of Dallas, Texas, is the centrepiece of the watershed and without doubt is one of the most biologically diverse areas in Texas. Approximately 3,300ha of the lake and surrounding wetlands were designated a Ramsar site in 1993, becoming the thirteenth such site in the USA.

The Caddo Lake Institute, a private operating foundation, has played a key role in the designation of the wetland as a Ramsar site and continues in its broader role as an 'ecosystem-specific' NGO and sponsoring entity, underwriting local wetland science and conservation education, as well as cultural and ecological research and monitoring. The Institute's Caddo Lake Scholars Program has created and provided specialized wetland science training to local colleges, public school educators and students, using the Caddo Lake wetlands as a living laboratory and classroom.

Diversity of Plant and Animal Life at Caddo Lake

A summary of the available information on the vertebrate life recorded at Caddo Lake and its associated wetlands is shown in Box 11. In terms of its plant life, 189 species of trees and shrubs, 42 woody vines, 75 grasses and 802 other herbaceous plants have been identified in the Caddo Lake wetlands and 48 of these species are mainly restricted to hardwood bottomlands and

associated wetlands. The watershed is the home of 44 animals, plants or plant communities considered endangered, threatened or rare by Texas Parks and Wildlife Department. Twenty four vertebrate species indigenous to the area are on federal endangered or threatened listings.

Bottomland hardwoods constitute a major vegetation cover within the Cypress Bayou-Twelvemile Bayou Basin, an area which includes Caddo Lake and its wetlands. Two distinct bottomland cover types are recognized: Baldcypress swamp/ flooded hardwood forest and bottomland mixed hardwood forest.

BOX 11: A SUMMARY OF SOME OF THE AVAILABLE INFORMATION ON VERTEBRATE LIFE AT CADDO LAKE AND ITS WETLANDS

As many as 261 bird species may use the 3,400ha Longhorn Army Ammunition Plant habitat and adjacent Caddo Lake wetlands and uplands at some time during a given annual period.

Of an estimated 181 mammalian species known to be in Texas, the Caddo Lake wetlands shelter more than 50. Some of these have already been mentioned and there been recent reports of sightings of several large cats believed to be Cougar*Felis concolor*, and the Louisiana Black Bear (*Ursus americanus luteolus*).

The 53 species of reptile thought to occur includes two wetland specialist species, the American Alligator *Alligator mississippiensis* and the Alligator Snapping Turtle *Macroclemys temminckii*, 16 other turtle species and approximately 30 species of snake.

71 species of fish have been recorded and this makes the lake and associated wetlands the richest site in the state.

31 of the 63 (48%) of Texas' amphibian species are found in the ecosystem.

Baldcypress swamp/ flooded hardwood forest occurs throughout the Caddo Lake watershed. The vegetation is dominated by the Southern Baldcypress *Taxodium distichum,* a large, broad-based (buttressed) coniferous tree which is considered a pioneer species of southern wetlands. The trees are slow growing, but once they establish themselves in monocultural stands of even-aged cohorts, they are able to occupy permanently flooded areas. Trees of 250 to 350 years of age are not

uncommon in the Caddo Lake ecosystem and the reported longevity elsewhere of this species can exceed a thousand years.

Although Baldcypress dominates the swamps, several other major species are associated with it such as Water Oak *Quercus nigra*, Willow Oak *Q. phellos* , and Water Tupelo *Nyssa aquatica*. There is also a great diversity of wetland shrubs, sedges, and rushes as well as 42 species of floating and submerged macrophytes.

Cypress swamps in general are highly productive ecosystems and the community at Caddo Lake represents one of the best examples of its kind in the state, supporting many animal species restricted to wetlands such as American Alligator *Alligator mississippiensis,* Alligator Snapping Turtle *Macroclemys temminckii*, Beaver *Castor canadensis*, Muskrat *Ondatra zibethicus* and Mink *Mustela vison*. The swamps are also of considerable importance as wintering and production areas for waterfowl especially Wood Duck *Aix sponsa* and Mallard*Anas platyrhynchos*, but including significant numbers of Northern Pintail *Anas acuta*, Gadwall *A. strepera*, American Wigeon *A. americana*, and Green-winged Teal *A. clypeata*.

Mixed bottomland hardwoods occur along streams and tributaries and are the most extensive of the two main vegetation types. Water and Willow Oak are the dominant species here, but they are associated with many other tree species and a variety of other plants. This type of vegetation contains areas of old growth and virgin hardwoods and one of the largest and most remarkable examples of such areas is found within the 3,400ha Longhorn Army Ammunition Plant (LHAAP), a federally-owned facility located on the southerly shores of Caddo Lake. The most significant of its forested wetlands is the Harrison Bayou virgin/old-growth bottomland forest. This 510ha forest has been characterized as a model southern bottomland hardwood wetland in both structure and ecological function. Approximately half of the Harrison Bayou forest is virgin forest and the balance is naturally regenerated, old growth, bottomland mixed forests.

These bottomlands are not only important areas for forest dwelling species such as White-tailed Deer *Odocoileus virginianus*, Raccoon *Procyon lotor*, Swamp Rabbit *Sylvilagus aquaticus* and Barred Owl *Strix varia*, but also provide habitat for resident waterfowl and function as an important migratory corridor for waterfowl which use the area for cover, resting and feeding. In addition, they serve as a haven for over 50% of all neotropical migrant songbirds listed by the US Fish and Wildlife Service as occurring in North America.

This forest community is significant when one considers that the US has lost approximately 50% of the wetland acreage that existed in the lower 48 states prior to European settlement and that between 1883 and 1991 the southern bottomland hardwood forest acreage decreased by 77%. The 23% that remains is being fragmented and has lost much of its original ecological role.

Caddo Lake and its associated wetlands are home to many species or plant communities which are of special concern. Globally threatened species include Red-cockaded Woodpecker *Picoides borealis*, Piping Plover *Charadrius melodus* and Alligator Snapping Turtle (IUCN Red List, 1994) and there are many other species which are either Federally or Texas listed.

Threats to the Caddo Lake Wetlands

Cypress swamps are very fragile and are becoming increasingly scarce within the state as a result of any number of activities such as timber harvesting, channelization and other land-use activities which alter the hydrologic conditions in ways which preclude regeneration of the key species, the Southern Baldcypress. This species is unable to regenerate on a permanently flooded substrate and the seedlings cannot tolerate long periods of complete submergence; successful regeneration is believed to be dependent upon appropriate flooding and drying patterns . At Caddo Lake mature trees are surviving the current permanent inundation, but there is little regeneration taking place in permanently flooded areas. The alleged low regeneration rates elsewhere are the subject of studies by the National Biological Service and the Caddo Lake Institute.

Populations of American Beaver *Castor canadensis,* and an introduced species of Nutria*Myocastor coypus* are regarded as potential risks to healthy generation and regeneration of old-growth and Baldcypress forest remnants and do not seem to be well controlled by predators in the area. Nuisance macrophytes include duckweed *Lemna* sp., Hydrilla *Hydrilla verticillata*, Water Hyacinth *Eichhornia crassipes*, and water lilies *Nuphar luteum* and*Nymphaea odorata*. There is also concern about elevated levels of heavy metals such as mercury, cadmium, lead and selenium.

In 1995, Texas state authorities advised against frequent consumption of Largemouth Bass because of the mercury levels detected in tissue samples of this fish. Elevated levels of fecal coliforms were found in the course of preliminary testing near small lakeshore communities by the Caddo Lake Institute 1995 monitoring activities.

The Caddo Lake Institute's Scholars Program Awards Ceremony in May 1993 included the first 'State of Caddo Lake' announcement. In it Dr Jack McCullough compared his 1993 study findings with a similar study conducted in the 1980s. He recommended that additional efforts be made by appropriate agencies to control nutrient input into the lake because their levels appeared to be increasing, leading to an accelerated rate of eutrophication. He also urged that oil production in portions of the lake be monitored to insure minimal impact on the ecosystem.

His final remarks provide a fitting conclusion to this case study:

"In summary, I might say again, it is a fragile ecosystem. It is under stress. Efforts to alter the ecosystem through new construction projects - such as channelization, plans to raise the water depth or alter the hydraulic retention time - or any additional efforts to greatly increase development around the lake, should be controlled carefully, so we don't push this fragile system to the breaking point."

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CHAPTER 8

THE OCEANIA REGION

An Overview of the Wetlands in Oceania

By Roger Jaensch, Wetlands International - Oceania Program, Australia

The Region's Physical and Political Diversity

Oceania comprises Australia, New Zealand, Papua New Guinea (PNG) and the islands of the tropical Pacific, thus embracing a continent nation as well as some of the world's smallest island nations.

Most of Australia is relatively flat and geologically stable. In contrast, the large islands of Oceania are mountainous, and volcanic activity and earthquakes are commonplace. Snow-capped peaks occur in New Guinea above an altitude of 4,000m and there are many glaciers in New Zealand.

Hundreds of low islands and, in some cases entire countries, are founded on coral reefs. Although Australia has its 'wet tropics', the interior is generally arid, whereas the west coast of New Zealand is especially rainy and annual rainfall in the PNG highlands can be up to 10,000mm.

Ramsar's Oceania Region includes 16 independent countries, three of which are Contracting Parties to the Ramsar Convention. Australia and New Zealand are industrialized and rich in natural resources, with relatively stable economies and high standards of living. PNG, the Solomon Islands and arguably others, possess substantial natural resources but lack the infrastructure and human resources to move beyond developing country status. The smaller island nations are poor in natural resources except for the largely untapped wealth in the seas within their huge Economic Exclusion Zones. There are eight external territories in Oceania, divided among France (New Caledonia, Wallis and Futuna, French Polynesia), the United States (Northern Mariana Islands, Guam, American Samoa) and Great Britain (Pitcairn).

Wetland Types and Threats

Ephemeral lakes and swamps are abundant in the internal drainage systems of central Australia and fill at irregular intervals from massive flood events. Best known is Lake Eyre, which covers one million hectares and is up to 6m deep when full but normally is dry with a salt crust up to 50cm thick. Few people live in Australia's interior but extensive grazing by cattle and sheep has caused increased run-off, erosion and sedimentation in many catchments.

Seasonal wetlands of Oceania include the biologically-rich tropical floodplains of northern Australia and PNG (e.g. the Ramsar-listed Kakadu and Tonda wetlands) and lakes and swamps on coastal plains in the Mediterranean climatic zone of southern Australia (e.g. Forrestdale Lake, Bool Lagoon: both Ramsar sites). The tropical floodplains are threatened by the rapid spread of introduced species, notably exotic weeds in Australia and deer and fish in PNG; many of the temperate wetlands are affected by pollution and competing demands on water supplies.

Lake Pangua, Fly River floodplain, Papua New Guinea. This tropical floodplain supports populations of crocodiles and fishes which are harvested for both subsistence and commercial purposes.*(Photo: Roger Jaensch/Wetlands International)*

Permanent lakes occur in the Pacific in volcano craters (e.g. Lake Letas, Vanuatu), on raised coral atolls (Lake Te-Nggano, Solomon Islands) and where meandering lowland rivers block their own tributaries (Lake Murray, PNG: 64,700ha). Lakes blocked from the sea by sand-drift are common on the Australian coast (e.g. Lake Alexandrina) and highland valley lakes abound in New Zealand (e.g. Lake Te Anau). Due to low populations and remote locations, Pacific island lakes are relatively undisturbed, but many coastal lakes in Australia and New Zealand are foci for urban areas and have been seriously degraded due to reclamation, pollution and altered hydrological regime.

Oceania also has freshwater wetland forests. Paperbark *Melaleuca* spp. dominated swamp forests are a feature of northern Australia, sago palm *Metroxylon sagu* and *Terminalia brassii* swamp forests occur in PNG and the Solomon Islands, and diverse tropical forests stand in seasonally inundated wetlands on most of the larger Pacific islands. The *Melaleuca*forests are threatened by excessive burning and some tropical swamp forests are subject to unsustainable logging.

Mangrove forests occur on all sides of Australia which has the third largest mangrove area in the world, after Indonesia and Brazil. In the Pacific islands especially large, mostly undisturbed forests occur in PNG (Gulf of Papua 200,000ha) and other extensive areas are found in the Solomon Islands and Fiji. At Lake MacLeod in Western Australia, mangrove communities exist 15km inland, connected to the sea only by subterranean movement of seawater. Most of the human population of Oceania live in the coastal zone which results in considerable pressure on mangroves, especially in southern and eastern Australia and near urban centres in the Pacific islands. In one of the case studies from the region the relatively pristine and highly diverse mangroves of Hinchinbrook Island, off the Queensland coast, are described; tourism development is one of the more serious threats to part of this mangrove area. In Fiji, mangroves are among the few areas available for development and are being lost to agriculture and tourism projects.

The most celebrated of Oceania's coastal wetlands are its coral reefs, particularly the Great Barrier Reef of eastern Australia (1,600km), which together with the barrier reefs of New Caledonia (1,140km), are by far the world's longest barrier reefs. The coral reefs (barrier, patch, fringing and atoll formations) throughout Oceania provide vital subsistence resources for humans, especially in the smallest island groups. Reefs of Oceania are threatened by a trend towards unsustainable subsistence and commercial fishing, degradation from the siltation effects of upland logging on islands with steep mountains, heavy ecotourism pressures in some areas, and (locally) by urban pollution heightened by rapid population increase.

Shallow estuaries and bays are conspicuous around Australia and especially in the North Island of New Zealand. Many are the mainstay of major commercial fisheries. Worthy of special mention in this regard is Shark Bay, a World Heritage site in Western Australia, which also has large hypersaline embayments that support stromatolite (algal mound) formations of considerable

scientific interest. Of some concern is the Waikato Estuary in New Zealand which has been affected by altered hydrology due to hydroelectric development in the Waikato River catchment.

New Zealand is notable for its high country cushion bogs and lowland raised bogs, notably the Ramsar listed Kopuatai Peat Dome (10,201ha). Smaller bogs are scattered through the region, some being on mountains of small Pacific islands. The peatlands which form part of the Waituna Wetlands in New Zealand are the subject of one of the case studies and of particular interest is a cushion bog community occurring at sea level containing many alpine and sub-alpine species.

Notable occurrences of springs in Oceania are the mound springs of the Great Artesian Basin in central Australia and the thermal wetlands of New Zealand's North Island. Hose's Spring, on Christmas Island in the Indian Ocean, is one of Australia's Ramsar sites.

Biological Diversity of the Wetlands of Oceania

Wetland plants of the Pacific islands in general are poorly documented. However, it is known that of the 3,250 vascular plant species recorded from New Caledonia, about 75% are endemic and many occur in the Plaine des Lacs wetland. Wetlands in Australia (especially the southwest) support numerous endemic plant species including trees and shrubs (*Eucalyptus, Banksia, Agonis, Callistemon*, *Melaleuca* spp.), sedges and ground orchids. New Zealand wetlands also support a considerable number of endemic plant species, including some which are adapted to oligotrophic (low nutrient) conditions. Species that occur widely in other regions, especially Asia (e.g. lotus *Nelumbo nucifera*), are also present. In the Pacific islands, mangrove communities decrease in diversity from west (around 20 tree species) to east (a few species); affinities are with Asian species except the mangle*Rhizophorasamoensis* which is allied to American species.

Of special interest among the wetland mammals of Oceania is the threatened Dugong*Dugong dugon* (IUCN Red List, 1994): one of the world's largest populations survives in Australia's Shark Bay. Fruit bats are common in tropical wetlands; concentrations estimated at up to 250,000 have been recorded in flowering *Melaleuca* swamp forests in northern Australia. A peculiar egg-laying marsupial, the Platypus *Ornithorhynchus anatinus*, feeds underwater in streams of southeastern Australia.

Wetland reptiles are generally well represented in Oceania. The threatened Saltwater Crocodile *Crocodylus porosus* (IUCN Red List, 1994) occurs in Australia and PNG, where commercial harvest of animals and eggs occurs, and small populations persist in several Pacific islands such as Palau. Separate species of freshwater crocodile occur in Australia and PNG. File snakes *Acrochordus* spp. are seasonally abundant on the tropical floodplains: they are hunted in

PNG to prepare drum skins. Although marine turtles are declining in many islands due to over-harvesting and disturbance to nesting beaches, the region still has good populations of most species. The case study on the Arnarvon Islands in the Solomon Islands describes the conservation efforts at one of the largest nesting sites for the threatened Hawksbill Turtle *Eretmochelys imbricata* (IUCN Red List, 1994). Frogs are found even in desert wetlands of Oceania and the colourful Corroboree Frog *Pseudophryne corroboree*occurs in *Sphagnum* moss bogs in the Australian highlands.

More than 200 waterbird species occur in Oceania and all major waterbird groups are represented. The case study on Lake Gregory, northwestern Australia, highlights the spectacular numbers of waterbirds which can occur at desert wetlands: peak counts of 600,000 have been recorded in exceptional years with around 100,000 regularly occurring. About half of the waterbird species recorded in Oceania breed in Australia and many are endemic to the continent. Five duck genera are endemic to Australia and endemic duck species occur in the mountain streams of PNG and New Zealand. A small suite of waterbird species (e.g. the widespread Spotless Crake *Porzana tabuensis*) occurs in the Pacific islands; more than a dozen species are endemic but several are believed extinct.

Forty percent of the world's shorebird species, including more than 50 trans-equatorial migrants, occur in Oceania. More than two million shorebirds arrive each year from northeast Asia, via the East Asian - Australasian Flyway, and to a lesser extent from North America via the Pacific flyways. These include the greater part of the global populations of Latham's Snipe *Gallinago hardwickii* (using freshwater marshes), Great Knot *Calidris tenuirostris* (intertidal flats), Little Curlew *Numenius minutus* (permanent waterholes in tropical grasslands) and the threatened Bristle-thighed Curlew *N. tahitiensis* (reef flats of Polynesia and Micronesia) (IUCN Red List, 1994). Notable examples of shorebirds endemic to Oceania are Banded Stilt *Cladorhynchus leucocephalus*, which breeds, spasmodically, in large colonies in Australian salt lakes, and Wrybill *Anarhynchus frontalis*, which has a laterally asymmetrical bill ideal for extracting mayfly larvae and fish eggs from undersides of stones in New Zealand river-beds. The threatened Tuamotu Sandpiper *Prosobonia cancellata* (IUCN Red List, 1994) occurs only in the Polynesian islands and is close to extinction.

Due to geographic isolation, the freshwater fish fauna of Oceania is poor in species from the 'true' freshwater fish genera found in Eurasia but includes many endemics. PNG has more than 300 freshwater fish species, many shared with northern Australia, and rainbowfishes (Melanotaeniidae) and blue-eyes (Pseudomugilidae) are unique to the combined sub-region. Lake Kutubu, in the limestone highland of PNG, has 11 endemic fishes. Notable fishes of Oceania include the Australian Lungfish *Neoceratodus forsteri*, which can respire with lungs and gills and is related to species in Africa and South America, and the Salamanderfish*Lepidogalaxias salamandroides* of southwestern

Australia, which survives under swamp-bed detritus when its blackwater acid-peat habitats are dry. New Zealand's endemic Black Mudfish *Neochanna diversus* is found in the Kopuatai Peat Dome (a Ramsar site) and has a limited distribution.

Many of the marine crustaceans in the region are important for subsistence (e.g. mangrove crabs *Scylla* spp. and *Macrophthalmus* spp.) and commercial fisheries (e.g. prawns *Penaeus*spp.). BLche-de-mer (sea cucumber) and *Trochus* are harvested but yields have declined in many countries.

Diversity of marine life generally declines from west to east in Oceania: reefs in the northwest, around Palau, are particularly rich. With more than 600 species of coral in the Pacific, the world's most biologically rich reefs occur in Oceania.

The Future Of Wetland Biodiversity in Oceania

Although human populations in Oceania are low in a global context, substantial threats to wetlands and their biodiversity nevertheless exist. Notable examples are fragile arid-zone wetlands starved of life-giving water and island mangrove and coral reef systems under pressure from fast increasing human use of limited resources. A fundamental strategy for reducing threats throughout Oceania will be to increase community appreciation of wetland biodiversity and community participation in wetland management. Management methods will vary according to land tenure systems: mainly state ownership in Australia and New Zealand but mostly customary ownership in the Pacific islands.

At present PNG is the only Contracting Party in the Pacific islands region. Recent efforts to demonstrate that membership of the Ramsar Convention has potential benefits for communities using mangroves and coral reefs has sparked interest in accession by several countries. However the capacity of conservation agencies of these countries to allocate staff time and resources to wetland issues remains low. Provision of appropriate support therefore should be a high priority for the Ramsar Convention, partner organizations and other relevant Conventions.

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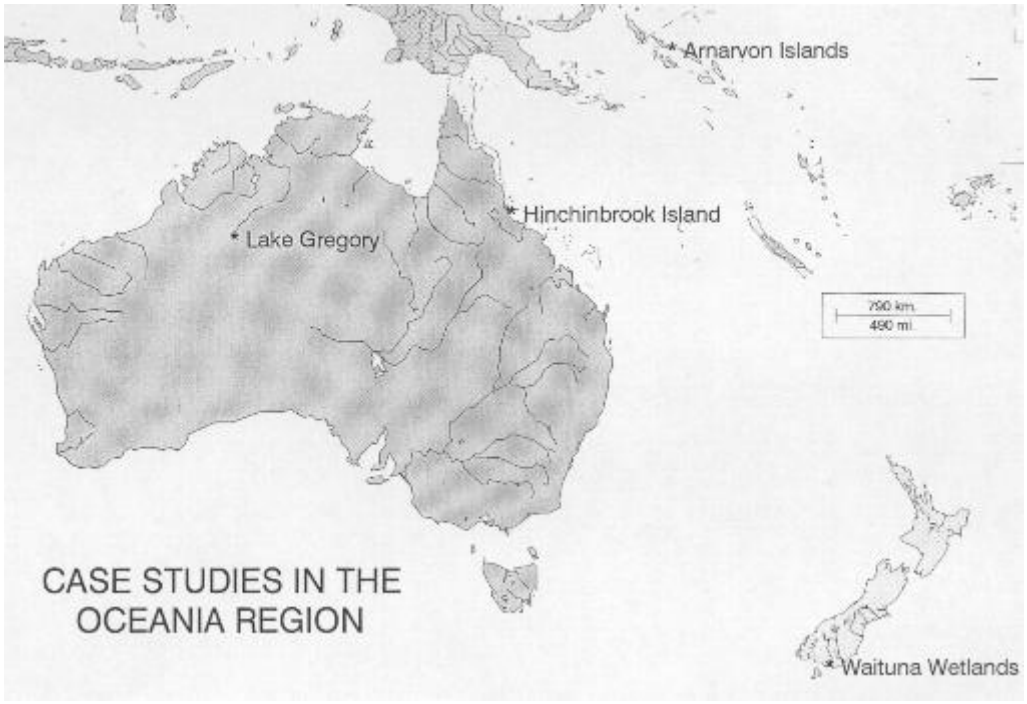

Case Study 1: Australia

Mangroves on Hinchinbook Island

By Joanna Ellison, Australian Institute of Marine Science, Australia

Importance of the Site

Hinchinbrook Island is the largest island (393km2) off the Queensland coast. The terrain is mountainous, rising to 1,121m, and covered with dense rain forest. It is separated from the mainland to the west by the Hinchinbrook channel, which is fringed by 164km2 of mangroves, and a further 50km2 of mangroves occur in the leeward Missionary Bay to the north of the island. The island is a National Park, and the mangroves are in a relatively pristine condition.

Because of environmental variability in mangrove habitats at Hinchinbrook, the mangroves are unusually diverse, with 27 species commonly found. There is considerable diversity of forest character, both floristically and structurally, ranging from Red or Stilt-root Mangrove stands *Rhizophora* spp. attaining heights of above 20m near the waters edge, to stunted Yellow Mangrove thickets *Ceriops* spp. fringing extensive areas of uncolonized bare mud in parts of the upper intertidal zone. Grey and Large-leafed Mangrove *Avicennia* and*Bruguiera* spp. also dominate forest structure in particular locations. Towards the landward margins, conditions are found that uniquely favour individual species such as Looking-glass*Heritiera littoralis*, Black *Lumnitzera* spp., Cannonball *Xylocarpus granatum* and Yamstick Mangrove *Scyphiphora hydrophyllacea*.

Fresh and brackish swamp communities occur in narrow bands on poorly drained sites transitional between dryland vegetation and mangroves in Missionary Bay. These communities vary floristically according to local conditions, such as water depth and salinity, but typically include a tree canopy of Paperbark *Melaleuca quinquenervia,* with screwpine*Pandanus* spp., and a ground layer of sedges, grasses and ferns.

The fauna of the mangroves is highly diverse, including numerous species of microscopic and substrate infauna of great importance to the sediment chemistry and foodchains. More visible fauna include molluscs, crabs *Sesarma* and *Uca* spp., mud-skippers *Periophthalmus*spp., numerous snakes, Black Flying Fox *Pteropus alecto* and the threatened Estuarine Crocodile *Crocodylus porosus* and Dugong *Dugong dugon* (IUCN Red List, 1994) as well as numerous fish and birds.

Research at Hinchinbrook Island

In 1972 the Commonwealth Government of Australia created the Australian Institute of Marine Science (AIMS), located it at Townsville in North Queensland, and commissioned it with tropical marine research. Missionary Bay on Hinchinbrook Island was selected as a key mangrove research site because of its high diversity, pristine condition (owing to the National Park status of the island since the 1930s), and relative proximity to Townsville 100km to the south. A 400m boardwalk was constructed through the mangroves extending south from Coral Creek to facilitate regular access, taking months of labour, vessel support, and the skills of the Australian Army engineers. Since 1974 a range of research projects (see Box 12) has been carried out and the intensity of scientific effort at Missionary Bay has made it one of the best studied mangrove systems in the world, and the basis

for expansion of research effort by AIMS to other sites in Queensland, N.W. Australia, Asia and the Pacific.

BOX 12: RESEARCH WORK PAST AND PRESENT AT HINCHINBROOK ISLAND

Past research projects have included:

studies of inshore productivity, with a focus on mangrove ecosystems;
studies of mangrove floristics and litter productivity;
monitoring of nutrient levels and particulate organic load in tidal waters of Coral Creek, undertaken using a small 'treehouse' laboratory constructed on the boardwalk. This had electric power, and allowed immediate treatment of water and other samples under clean and sheltered conditions;
an extensive topographic survey, with tidal monitoring and channel profiling, of Coral Creek in Missionary Bay. This facilitated:
a study of the mangrove creek hydrodynamics undertaken to assist nutrient budget studies;
the development of a circulation model for the larger Hinchinbrook channel;
an investigation of Holocene stratigraphy and palaeoecology of mangrove and offshore areas of Missionary Bay showing migration of the mangrove area with sea-level changes;
an investigation of tidal export of mangrove material and the significance of this in foodchains.

Current research includes:

mudflat and mangrove sedimentation history, geochemistry and offshore deposition of mud from the Herbert River;
a continuation of studies on tidal exports from mangroves and the carbon cycle, faunal foodchains and forest productivity

Developments and Utilization

Adjacent to the Hinchinbrook channel about 6km south of Cardwell is Seafarm, the largest prawn pond operation in Australia. There are 60ha of 50 constructed ponds and 73 under construction to a total of 120ha, largely cleared from lowland *Melaleuca* forest. There is year-round production and discharge into the Hinchinbrook channel. This is monitored by both Seafarm and the Queensland Department of Environment and Heritage and maintained within tight limits set on nitrogen, phosphorous and suspended solid levels. This is a professionally run operation that has minimized its impact with on-farm management.

The whole of Hinchinbrook Island is a National Park, but the northern tip of Cape Richards is leased as a low-key tourist resort (up to 60 people), connected by a boat service to Cardwell. From here tourists can access the eastern coastal walk via a short boardwalk from the southeast corner of Missionary Bay mangroves to the Ramsey Bay beach.

Two kilometres south of Cardwell is Oyster Point or Port Hinchinbrook, the site of ongoing controversy regarding development of a large marina-resort. The 44ha site was purchased in May 1993, and a resort was proposed to accommodate 1,500 guests, and a 250 berth marina. Including earlier work by a failed developer, work at the site has achieved clearing of vegetation and mangroves along the foreshore, excavation of the marina basin, partial excavation of the channel within the site, construction of access roads, and commencement of beach formation works.

On 15 November 1994 the Governor-General, on the advice of the Federal Minister of the Environment, stopped work for a more thorough assessment of potential damage of the development to the Great Barrier Reef World Heritage Area which includes the Hinchinbrook channel. Two scientific workshops were called, and an assessment carried out to determine the environmental impacts of the developer's application to construct breakwaters, dredge an outer channel and implement a beach and foreshore management plan. This showed that there was potential to damage the World Heritage Area, mainly through sediment disturbance and effects on seagrass beds in the channel, and as a result the application to build breakwaters, a marina and an artificial beach was not granted, though the resort development was approved. In October 1995 a site assessment by the Great Barrier Reef Marine Park Authority indicated that moderate to severe erosion problems had developed at the partially cleared site, and recommended a foreshore monitoring programme.

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Case Study 2: Australia

Lake Gregory

By Stuart A. Halse, Department of Conservation and Land Management, Australia

Lake Gregory is a large, semi-permanent lake system on the Great Sandy Desert, northwestern Australia. The contrast between the vast expanse of water, with its fringing trees and shrubs, and the surrounding spinifex-covered sand dunes of the desert, provides the main visual attraction of the lake. High numbers of terrestrial plant and animal species, as well as aquatic organisms, occur because of the availability of water.

Major Physical Features

Lake Gregory has a catchment of 65,000km2 that extends approximately 300km northeast out of the desert into an area of comparatively high monsoonal rainfall. Run-off generated in the catchment enters the lake via Sturt Creek, which breaks into a series of small channels as it approaches the lake. Despite annual evaporation of 3,900mm, Lake Gregory contains water about nine years out of ten. There is no outflow from the lake, other than some groundwater recharge, and large volumes of water are stored after the major inflow events that occur every few years. Sturt Creek forms the headwaters of an ancient river system that was cut off from the coast when desert dunes developed west of Lake Gregory during the Tertiary; lakes have occurred at the site of Lake Gregory since the late Cainozoic.

Lake Gregory consists of three parallel inter-connected chains of lakes with the largest and deepest waterbody, Mulan, being in the eastern chain. When flooded to its normal boundary, the system covers 380km2 and Mulan is approximately 5m deep. After major flooding, such as occurred in 1993, the system covers 1,300km2 and Mulan has a depth of 12m.

Temporary wetlands to the north of Rilya, created after the major flooding which took place in 1993. *(Photo: Stuart A. Halse)*

Salinity of water in the system varies from approximately 100mg/l in the western lakes after flooding to 80,000mg/l in Bulbi and Mulan as they dry. The western lakes probably always contain fresh, turbid water when inundated but the eastern lakes, and Bulbi in the central chain, vary from turbid and fresh to clear and saline according to water depth. Evaporation and a decanting process from the western and northern waterbodies towards Mulan and Bulbi are responsible for high salinities (> 20,000mg/l) observed in those waterbodies for approximately six months before the system dries. High pH (up to 11) is often recorded at Lake Gregory, probably as a result of photosynthesis, and levels of silica often exceed 30 mg/l. Water in the western lakes contains a high proportion of bicarbonate, whereas that in the eastern lakes is dominated by sodium chloride. The ratio of calcium/(bi)carbonate is usually <1, which is unusual in Australian arid-zone lakes.

Biodiversity of the Lake

Biological research at Lake Gregory has concentrated on documenting use of the system by waterbirds and aquatic invertebrates. Seventy one species of waterbird have been recorded, 21 of them breeding. Numbers exceeded 600,000 in March 1988 and 240,000 waterbirds were counted in August 1986, although it seems that most years numbers peak at about 100,000. Numbers are usually highest towards the end of the dry season, which lasts from May to October. Lake Gregory probably supports among the highest waterbird numbers of any non-marine wetland in Australia. Dominated numerically by ducks, especially Grey Teal*Anas gracilis,* Pink-eared Duck *Malacorhynchus membranaceus* and Hardhead *Aythya australis*, there are also high numbers of Little Black Cormorant *Phalacrocorax sulcirostris,*Eurasian Coot *Fulica atra* and sometimes migratory waders including Oriental Plover*Charadrius veredus.* Eight thousand active nests of Little Black Cormorant were recorded in 1986.

The large number of fish-eating birds in the system reflects the abundance of Spangled Perch*Leiopotherapon unicolor*. Lake Gregory also supports a rich invertebrate fauna; the list of 175 species exceeds that recorded for any other arid-zone lake in Australia. Most of the invertebrates in the system are relatively small with insects, crustaceans and rotifers being the dominant taxonomic groups. Very few halophilous species of invertebrate (those which thrive in the presence of salt) occur when the system is saline, emphasising that Lake Gregory functions principally as a freshwater lake.

Management Issues

Lake Gregory is located within a pastoral lease held for the Mulan Aboriginal Community since 1977. The principal management issue from a conservation viewpoint is the loss of fringing vegetation around the lake that has occurred over the past 50 or more years. *Acacia maconochieana,* which dies after prolonged inundation, is the most common fringing tree and provides nesting sites for many birds, especially the large colonies of cormorants. *Acacia maconochieana* trees die during periods of high lake levels but are replaced by seedlings as water levels recede. This provides a mixed belt of live and dead trees around the lake, which is critical to the maintenance of its ecological character. Unrestricted access of cattle to the shore of the lake, and the consequent grazing of seedlings, prevents regeneration of the tree belt. Broad-scale erosion in the catchment with an increased rate of siltation in Lake Gregory may also be a significant issue.

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Case Study 3: New Zealand

Waituna Wetlands Scientific Reserve

By Brian Rance and Wynston Cooper, Department of Conservation, New Zealand

Introduction

Waituna Wetlands comprise an area of approximately 3,556ha situated on the southern coast of the South Island of New Zealand. The wetlands encompass the Waituna Lagoon along with adjacent peatlands, numerous ponds/lakes and coastline forming part of a larger complex of estuaries and lagoons within the Southland area.

Conservation of flora and fauna, and protection of wildlife are the primary uses of the wetland. However, other uses include sport fishing (for Brown Trout *Salmo trutta*) and game bird shooting. Much of the surrounding area is used for pastoral agriculture.

Major Wetland Types

Within the wetland there are:

Peatlands: this vegetation is governed by the height of the water table and drainage. The most extensive vegetation type is Wire Rush *Empodisma minus* with Tangle Fern *Gleichenia dicarpa*, Manuka *Leptospermum scoparium* and *Dracophyllum longifolium.* Better drained areas are dominated by *Leptospermum scoparium* shrublands or Red Tussock *Chionochloa rubra (*local). Low lying sites are generally dominated by sedges, rush and bryophytes with ponds or pools. One of the special features is a cushion-bog community containing many species adapted to cold, peaty conditions including some species more typically found in montane or subalpine conditions rather than at sea level. The wildlife in the peatlands is not diverse but the area forms the Southland stronghold for Australasian Bittern *Botaurus poiciloptilus*, South Island Fernbird *Megalurus punctata punctata*, Spotless Crake *Porzana tabuensis* and Marsh Crake *P. pusilla.* All these species have declined elsewhere through habitat loss in Southland.

Waituna Lagoon, ponds and lakes: Due to periodic opening to the sea following the lagoon reaching high water levels, the lagoon is subject to considerable fluctuations in water level. It is a different habitat when open to the sea and thus tidal, from when it is closed and ponded. When open there are extensive tidal mudflats, which form an important summer wader habitat. A large number of wader species (including up to 18 species of trans-equatorial waders) utilize the mudflats. Other waterfowl also utilize Waituna Lagoon as well as the numerous small ponds and lakes. In particular Waituna Lagoon is the principal Black Swan *Cygnusatratus* site and one of the most important Grey Duck *Anas superciliosa* sites in Southland. There is a Black Shag *Phalacrocorax carbo* colony on one of the ponds. The lagoon is a trout fishery of some importance. Several types of vegetation associated with the lagoon edge are present - saltmarsh and allied communities are extremely well developed in southeastern New Zealand.

Gravel coastal beach: This contains a discontinuous vegetation of grasses, herbs and shrubs, most common being *Muehlenbeckia axillaris*, *Gentiana saxosa*, and *Poa cita.*

Streams and waterways: Sea-run Brown Trout are found in the Waituna Lagoon. The streams provide spawning grounds for both the introduced trout and native fish. Populations of Giant Kokopu *Galaxias argenteus* and Banded Kokopu *Galaxias fasciatus*, Inanga*Galaxias maculatus*, Long Finned and Short Finned Eels *Anguilla dieffenbachii* and *A. australis* as well as other estuarine and freshwater fish have been recorded.

Major Features of the Waituna Wetlands

Waituna Lagoon was designated a Ramsar site in 1976 since it met three of the four 'Ramsar General Criteria based on plants or animals' for identifying such sites: it supports an appreciable assemblage of endemic and/or threatened species and communities; it has special value for maintaining the genetic and ecological diversity of the region; and it provides a habitat for plants and animals at critical stages of their biological cycles.

Notable endemic taxa include:

Fish:

- Giant Kokopu *Galaxias argenteus;* National status: vulnerable
- Banded Kokopu *Galaxias fasciatus*; National status: vulnerable

Birds:

- New Zealand Shoveler *Anas rhynchotis variegata*; uncommon endemic subspecies
- Variable Oystercatcher *Haematopus unicolor;* National status: rare
- South Island Pied Oystercatcher *Haematopus ostralegus finschi;* uncommon endemic subspecies
- South Island Fernbird *Megalurus punctata punctata*; National status: rare
- New Zealand Dotterel *Charadrius obscurus obscurus;* National status: endangered (less than 100 individuals remaining)
- Banded Dotterel *Charadrius bicinctus bicinctus*; National status: vulnerable

Plants:

- Pingao *Desmoschoenus spiralis*

- Tufted Hair Grass *Deschampsia caespitosa var. macrantha*, endemic subspecies, National status: vulnerable

Aside from these species of special significance, the area supports a large diversity of birds, native fish, invertebrates and plants. Seventy six species of birds have been recorded, including both international and internal migratory waders. A significant aspect of the migratory wader population is the number of rare species (by New Zealand standards) that have been recorded in the reserve. These include Mongolian Dotterel *Charadrius mongolus*, Grey Plover *Pluvialis squatarola*, Marsh Sandpiper *Tringa stagnatilis*, Sanderling *Calidris alba* and Asiatic Whimbrel *Numenius phaeopus variegalus*. The wetlands also serve as an important moulting refuge for the New Zealand Shoveler. Native fish species include several endemic species some of which are rated as vulnerable. Many of the insects and some plants are typically subalpine species. Over 80 species of moth alone have been found in the Awarua Bay/Waituna Wetlands complex and the area is the type locality for a number of species of moth, some of which are not known to occur elsewhere. The diverse flora of the area includes the presence of the interesting cushion bog vegetation and sand ridge plant associations (Pingao, Coastal Tussock and locally uncommon species of mat-daisy).

Current Status

The wetland, which is Crown-owned and managed by the Department of Conservation, was gazetted as a Scientific Reserve in 1983. Entry to the reserve is not restricted, but the relative isolation and difficulty of access ensure minimum disturbance. Monitoring continues on lagoon levels, effects of past fires and the impact of nesting gulls on the cushion bog vegetation. There are also bi-annual wading bird counts undertaken at Waituna Lagoon.

The Wetlands of Ecological and Representative Importance database gives the wetland a ranking of international importance and the wetland was designated a Ramsar site in 1976. The Department of Conservation is investigating the expansion of this Ramsar site to include additional wetland areas.

Major Threats and Management Issues

There are three major threats to the wetland:

- fires - there have been several large fires in adjacent peatlands in recent years;
- in the area surrounding the wetland, an intensification of land use including draining, ploughing and sowing grass influences water quality;
- exotic weed species - Gorse *Ulex europaeus*, Broom *Cytasus scoparius* and Spanish Heath *Erica lusitanica* are found in peripheral areas and are spreading within the wetland.

When the sea outlet from the lagoon is blocked during periods of high rainfall, the water floods back into marginal vegetation. This is a desirable feature for many of the reserve's botanical features which remain because of the occasional flooding of areas and maintenance of a high water table. If this occurs during July-November it can stimulate the breeding activity of Black Swan to a marked degree. However, it can also be detrimental for other species such as waders, as the mudflats used for feeding are not exposed, or for terns, oystercatchers and stilts when the small islands they favour as nesting sites are submerged. Blocking of the inlet also causes drainage problems on some farms close to the lagoon, so a management regime exists whereby periodically the bar is artificially opened to the sea.

Case Study 4: Solomon Islands

The Arnarvon Islands

By Edward Mayer and Susan Brown, Nature Conservancy, Solomon Islands

Arnarvon Islands, A Community-Managed Conservation Area

On 22 August 1995 the first community-managed conservation area in the Solomon Islands officially opened at the Arnarvon Islands. The opening was the culmination of over five years work that included marine turtle surveys, a rapid ecological assessment, extensive community consultations, hiring and training of local conservation officers, and the development of a marine resource biological monitoring programme with completion of the surveys begun before the establishment of the conservation area. The conservation area project at the Arnarvons is a partnership between the Solomon Islands Ministry of Forests, Environment and Conservation (MFEC), The Nature Conservancy (TNC), and the Communities of Kia, Posarae, and Waghena.

An anchialine tidal flat where there is no surface exchange of water - the barrier of sand between the flat and the lagoon is clearly visible.*(Photo: Edward Mayer)*

The Arnarvon Islands are located in the Manning Straits, midway between Choiseul and Isabel Islands, two large mountainous islands in the Solomon Archipelago. The conservation area comprises approximately 82.7km2 of islands and reef, with a

total land area approximately 3km2. The island group consists of three low relief islands, with a diverse mix of shoreline habitat.

Significant areas of tidal flats are found throughout the islands. A number of small completely enclosed tidal flats exist which have no surface exchange with sea water (called anchialine ponds). These ponds fill and drain through tide-driven subterranean movement of water. Several large barachois tidal flats (areas which have surface exchange with the lagoons) occur on all three islands.

Marine and Terrestrial Diversity

The area is recognized as the largest and most important nesting site in the Western Pacific of the threatened Hawksbill Turtle *Eretmochelys imbricata* (IUCN Red List, 1994). There has been a significant decline in the populations of nesting turtles in recent years. Early surveys, together with anecdotal information from local residents, estimate the population of nesting turtles to be of the order of 500 annually. Recent surveys have shown a decline to less than 100 annually. The reduction in nesting turtles reflects the excessive harvest of Hawksbills for the turtle shell (*Bekko*) trade with Japan. While the Bekko trade is now prohibited, there is still pressure on the marine turtles because of hunting for domestic consumption of the meat. Concern about this decline led to the establishment of protected status for the islands.

The reef areas surrounding the islands contain at least 43 genera of hard corals and 6 genera of soft corals dispersed over outer fringing reefs exposed to ocean conditions, submerged platform reefs, and sheltered lagoon reefs. This diversity of reef habitat supports numerous species of reef fish in great abundance, including the herbivorous Scarids and Acanthurids, and schools of Giant Humphead Parrot Fish *Bolbometopon muricatum*, all good indicators of a lack of fishing pressure. In contrast, the sedentary marine resources have experienced a rapid decline due to heavy harvesting pressure. The area, once abundant in *Trochus*, Blacklip and Goldlip Pearl Oyster *Pinctada margaritifera* and *P. maxima*, and approximately 15 species of Béche-de-mer (sea cucumber), is now seriously depleted. The six species of giant clam *Tridacna* spp. still have a relatively high population density at the Arnarvon Islands despite harvest pressure, making this one of the last places in the Solomons to support a viable population.

One hundred and four species of plants were recorded on the islands during the 1993 rapid ecological assessment, ranging from epiphytic plants to large coastal forest trees. Six different forest types were identified on the islands; Coastal Strand Forest with *Casuarina*,*Pandanus* Swamp Forest, Tall Coastal Strand Forest, Swamp Forest predominately *Pemphis acidula*, Mangrove Swamp Forest, and a small patch of Lowland Rain Forest.

The Arnarvons are a good example of undisturbed low island ecosystems and for their size have a diverse terrestrial fauna. Six species of bats and five species of flying fox (or megachiropteran bats) were recorded on the islands, along with at least seven species of terrestrial reptiles. The islands have significant habitat for seabirds, waders, and migratory bird life, and of the 41 species recorded, there are 12 species of waders and migratory birds, and 6 species of sea birds. Sanford's Eagle *Haliaeetus sanfordi*, which is rare in the Solomons, is one of the four species of raptors present at the Arnarvons', along with the Brahminy Kite *Haliastur indus* which is the most commonly observed raptor. The sandy soil provides ideal nesting sites for the Arnarvon's abundant population of the megapode*Megapodius eremita*. There are several large communal nesting sites on Sikopo Island, which has the highest density of megapodes, while on Kerehikapa and Maleivona islands small nests are scattered throughout. The megapode's egg, as the name suggests, is extremely large for this chicken-sized bird, and has an extraordinarily high yolk to albumen ratio. They are regularly harvested for local consumption.

Community Management Initiatives

Although the islands of the Arnarvon Community Marine Conservation Area (AMCA) are uninhabited, there are a number of communities from Isabel and Choiseul provinces who claim traditional ownership, and are the primary users of the resources. From the beginning of the project, TNC and MFEC have involved these traditional resource owners and users as partners in the planning, establishment, and management of the AMCA.

Within the conservation area, the project works through the community controlled Management Committee, which has drafted a management plan and regulations for the area. This plan is being implemented by community hired Conservation Officers who are responsible to the Management Committee. Activities in the broader area concentrate on building community environmental awareness by focusing on the importance of sustainable levels of harvest, discouraging destructive methods of extraction, and transferring resource management methods learned in the AMCA to the broader area for the protection of resources on a regional level.

The collaborative project is making great strides in the accomplishment of its central objectives: to protect and sustainably manage resources in and around the Arnarvon Islands, and to ensure the viability of one of the world's largest nesting grounds for the threatened Hawksbill Turtle.

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CHAPTER 9

WETLANDS, BIODIVERSITY AND THE RAMSAR CONVENTION - CONCLUSIONS

By the Ramsar Bureau, Gland, Switzerland

Wetlands - A New Concept

The Ancient Greeks identified four basic elements: earth, air, fire and water. Modern environmental thinking emphasizes the need to take account of traditional knowledge and wisdom, so perhaps this ancient division of the properties of the physical world is an appropriate reminder that wetlands are the meeting places of two fundamental elements, water and earth. As noted by Peter Bacon in the first chapter, the way water and earth meet, the topographic gradient concerned, and the seasonal variations in rainfall or inundation patterns, account for the wide diversity of wetland types. Yet the importance of wetlands, for their intrinsic biodiversity, their productivity and their consequent value to human societies, has only recently been fully recognized. The very word 'wetland' is a recent coinage, not very elegant and difficult to translate, but which aims to sum up this new concept of the fruitful meeting of two elements.

Biological Diversity of Wetlands

The regional overviews illustrate the high levels of biodiversity found in wetlands. After tropical rain forests, they are among the richest ecosystems on this planet. Coral reefs, included in the Ramsar definition of wetlands, contain some of the highest known levels of biodiversity, while other coastal wetlands (including estuaries, seagrass beds and mangroves) are among the most productive. Other wetlands also provide sanctuary for a wide variety of plants, invertebrates, fish, amphibians,

reptiles and mammals, as well as millions of waterbirds. Of the world's 20,000 species of fish, approximately 8,500 live in fresh water. While many reptiles are dependent on wetlands for feeding and breeding, virtually all amphibians rely on wetlands for breeding and larval development. Wetlands support many mammals and some species, such as the hippopotamus, are highly specialized for an aquatic lifestyle. The spectacular migrations of some of the waterbirds - which may make a return flight every year from breeding grounds in northern latitudes to wintering grounds in far southern climes - provided the spur for the establishment, 25 years ago, of the Convention on Wetlands (Ramsar, 1971), still the only intergovernmental legal instrument to deal with a single ecosystem type.

The overviews and case studies from Ramsar's seven regions (the Eastern and Western European regions are treated in the same chapter in the present volume) provide many specific examples of this biodiversity. It goes without saying that many other examples might have been chosen, but the 29 presented give a taste of the variety of life to be found in them. Thus the ephemeral wetlands of Northern Namibia can be divided into several habitats, each with its distinguishing biodiversity. The Ebro Delta plays host to many plant species at both their northernmost and southernmost geographical limits, as well as to endemic fish and aquatic birds. The huge diversity of the Belize Barrier Reef is the result of careful partitioning of the reef by all its inhabitants which use it at different times of day or eat differing food. The mangrove habitats of Hinchinbrook Island in Australia are unusually diverse with 27 species of mangrove tree commonly found. The Berbak National Park in Indonesia is thought to be one of the world's most highly diverse areas in terms of palm species. The Berbak National Park in Indonesia is thought to be one of the world's most highly diverse areas in terms of palm species.

It is a sobering thought that the richness of freshwater systems is still poorly known, and that many wetland species, especially invertebrates, have yet to be described. Thus 10% of invertebrates recently sampled in the relatively well-studied Hong Kong Ramsar site of Mai Po Marshes were unknown to science.

Wetland Productivity

In parallel to this support of biodiversity, the introductory chapter by Peter Bacon, the overviews and case studies illustrate the productivity of wetlands. Wetland soils are rich in minerals and other nutrients, and Bacon quotes the example of Lake Naivasha in Kenya where papyrus swamps produced a harvestable standing crop of 30 tonnes per hectare (which furthermore was replaced after harvest in about nine months), compared with only 10 tonnes per hectare from the finest European pastures. Around two thirds of the fish consumed by human beings depend on coastal wetlands at some stage of their life cycle.

Thus there is an overwhelming case for the value of wetlands to human societies. These values may be derived from direct harvesting of fish, from hunting, grazing or agriculture, or through secondary activities like tourism and other human recreational activities; they may equally be provided, almost unrecognized and taken for granted by human societies, through essential functions performed by wetlands, such as control of floods and sedimentation, provision of water (including groundwater recharge), maintenance of water quality and abatement of pollution. These essential goods and services explain why wetlands were often the cradle for the development of human civilizations, like those of the Nile Delta, the Valleys of the Tigris-Euphrates and the Mekong, the fertile floodplains of India and China, or Lake Titicaca; the need to share and organize these wetland benefits was the spur for human beings to coordinate and regulate their activities and their use of natural wetland functions.

The Paradox

Here, in these dual features of wetlands - richness and usefulness - lies the supreme paradox and dilemma, the challenge facing modern day efforts to achieve sustainable development. On the one hand is the extraordinary wealth and variety of living forms and physical properties that exist in wetlands, so bountiful that it seems impossible they should ever be exhausted; on the other the deplorable fact that human use (or rather overuse) has in many cases been excessive, either because the desire for short term profit is destroying the basic wetland resource or the demands of a burgeoning population lead to its over-exploitation. How is this vast richness to be harvested wisely, in a way that will ensure it remains available to future generations?

While some wetlands are testimony to the positive effects of wise use of natural resources (e.g. the Bangladesh Sundarbans, a case study in the Asian chapter), to a large extent the overviews and case studies present abundant illustrations of the multiplicity of threats to wetlands: drainage for agriculture (often with subsequent salinization of soils); organic pollution from fertilizers or pesticides (e.g. in the English Norfolk Broads, Mai Po in Hong Kong and Tasek Bera in Malaysia); urban development, interruption of water flow notably by dams (e.g. at Djoudj in Senegal and Kelbia in Tunisia, or the Yaciretá Dam on the River Parana between Argentina and Paraguay); industrialization, overuse of groundwater (e.g. at Azraq); excessive tourist and visitor pressure.

Because of their own special features, coral reefs are vulnerable to a series of threats: sedimentation; agricultural run-off; coastal development; tourism; and overfishing. It is estimated that these threats have seriously degraded 10% of the earth's coral reefs and currently threaten many more .

One of the greatest threats to biodiversity is the introduction of alien species, whether plants (like Water Lettuce in Djoudj); or fish (such as the Nile Perch and a species of tilapia which have caused

a steep decline in the former highly diverse endemic fish fauna of Lake Victoria); or mammals which have been introduced in remote Tierra del Fuego where they and alien fish are a major threat to the few native species adapted to the harsh local conditions.

Human population growth and extension clearly have a massive impact on wetlands, sometimes to the point of destroying them completely. In north and west Europe, "the concentration of economic wealth and highly developed industrialization has seen the greatest loss, degradation and fragmentation of wetlands". The Namibian case study comments that population growth, as in many other African countries, is the single most important threat to the wetland. The Colombian Amazon is the homeland for indian tribes whose traditions were based on a reasonable understanding of the wetlands, so that their impact was almost negligible, whereas the pressure from a growing population of settlers from different regions might be a threat for the wetland ecosystems of the Amazon. In many countries, the need for water - whether for human consumption, agriculture, industry or tourist development - leads to major water supply projects based on construction of large dams and canals. Quite apart from their social impact on human populations downstream or upstream of the constructions, which may force long established settlements to be abandoned, these constructions have huge impacts on the functioning of the wetlands concerned. It has been said many times that water will be one of the major strategic resources of the 21st century. Until now, water supply projects have rarely taken account of wetland values and functions; there is a need in the future for water supply and wetland conservation to be effectively coordinated.

While these factors may threaten the very existence of some wetlands, at a more insidious level they threaten the biodiversity held within them: the frequent references to globally threatened species within the regional chapters is evidence of the scale of this problem.

Broader environmental factors, such as global climate change or desertification, also affect wetlands. Scientific evidence now clearly points to increasingly rapid changes in climate; Lake Chad was much larger 3,000 years ago, but if current predictions come to fruition, there will in the next 50 years be more extreme climatic events, more storms, droughts, floods. How will this affect current measures for wetland conservation? If climatic bands change, the protected wetlands could prove to be in the wrong place; risks of flooding or of desiccation and desertification, aided and abetted by unwise human use, could occur in quite new, unexpected areas.

What Future Action?

This dilemma of the conservation and wise use of wetlands illustrates in a microcosm the environmental problems posed to the world at the threshold of the 21st century. How is the wealth of the earth's many ecosystems to be conserved because of their intrinsic value, and yet be harvested wisely? Wetlands can provide a blueprint and a model for activities in other fields.

The Ramsar Convention, which has now been in existence for 25 years, and has accumulated considerable experience, fortunately offers some pointers to the way forward. The Convention takes as its starting point that international cooperation is necessary for the conservation and wise use of wetlands. So far 93 states are members, and it is clearly essential to ensure that all states become Contracting Parties; the 1997-2002 Strategic Plan therefore calls for universal membership and lays special stress on recruitment from the Caribbean, Near East, Southern Africa and the Pacific. In terms of substantive obligations, the Convention's two basic requirements - designation of wetlands for the List of Wetlands of International Importance, and application of the wise use principle - fit with the call, almost a cliché nowadays, to 'think globally and act locally'. The most important wetland sites, the 'crown jewels', should be designated for the Ramsar List, but not merely designated on paper, they must be managed and conserved (the Strategic Plan calls for all Ramsar sites to have their own management plan, and for 50% of these plans to be in place by 2002). 'Wise use' means taking a broader view at national level of all the factors impacting wetlands; hence Ramsar Contracting Parties should develop National Wetland Policies, or include wetlands in appropriate sections of other national planning instruments relating to natural resources and the environment, so that wetlands are given full recognition in the national procedures for water and land use planning, and so that appropriate structures and legislation are established.

To ensure full application of these two fundamental obligations, other actions, both theoretical and practical, are necessary:

(a) Need for a holistic overview

Since the holistic recognition of the importance of wetlands is so recent, there is as yet only a dim understanding of the global scale and size of the wetland resource. The Asian overview refers to regional wetland surveys of South and East Asia and the Middle East, which identify the major wetland sites in those areas. Similar surveys of internationally important wetlands exist for other regions, while many states have carried out a national wetland survey; thus the North American overview notes that Canada holds 24% of the world's wetlands, an area covering 1.27 million square kilometres. The full area of wetlands in the world is still, however, a matter of some dispute: the World Conservation Monitoring Centre has proposed an estimate of about 5.7 million square kilometres, roughly 6% of the world's land surface. UNEP reports that 47% of the land area of the world (excluding Antarctica) falls within international water basins shared by two or more countries.

(b) Need to establish rates of wetland loss

Once there is a better idea of the overall extent of the wetland resource, and of the size of the challenge facing its managers, the figures need to be put into a world and a historical context. How many wetlands need to be given protected status through national or international conservation

measures? There is as yet no clear vision of how many sites need to be protected at national or international level.

The extent of the threats needs to be defined. How does the present extent of wetlands compare with the situation in the past? There are estimates of the amount of certain types of wetland lost in certain countries: the North American overview states that, in the conterminous USA, only 47% of the original wetland coverage remains, though most of Alaska's wetlands remain undisturbed; the Asian overview notes that 85% of the wetlands in South and East Asia are threatened in some way and 50% are severely threatened. Yet there is no full understanding of the overall rate of wetland loss; it has certainly increased dramatically in the last 50 years, and more than half of the world's wetlands have been destroyed this century.

(c) Need to respect regional variation

How are solutions to be adapted to regional differences? In South America, Alaska, Africa and Eastern Europe, wetlands remain relatively untransformed, though the African section warns of the increasing impact of human population growth. In Western Europe there have been grave changes in the extent and functioning of wetlands, and in Central America, the Caribbean and USA too, major changes have come about. In the regions which have suffered major loss, wetland restoration will be a much greater priority, given that it is always much more difficult (if not impossible), and certainly more expensive, to restore lost wetlands than to conserve existing ones.

(d) Action at local, national and international level

Action for conservation and wise use of wetlands must quite clearly be taken at all levels - local, national and international. At local level, there is a need to involve and inform local communities, to ensure that they are aware of the values and functions of the wetlands in their immediate area, and that they are fully concerned in the management and use of such wetlands. Two of the case studies indicate how this might happen: in the Pacific Arnarvon Islands and Old Crow Flats in northern Canada, local communities have played a leading role in making and applying management plans for wetlands, effectively identifying these communities as custodians of wetland biodiversity. As noted in the North American overview, "it is apparent that the cumulative impact of many small individual actions (no single one of which is alarming) is becoming a major threat to the integrity of wetland landscapes". Such issues can only be tackled at local level by a community well aware of the impact of its actions, and this implies enormously increased efforts at creating public awareness, in many cases through the educational activities of non-governmental organizations (NGOs).

Action to implement the two major obligations under the Ramsar Convention, designation of internationally important sites and establishment of wise use policies, can only be undertaken by

national governments at national level. Furthermore, the establishment of National Wetland or Ramsar Committees, as recommended in the Strategic Plan, may help to promote a bottom-up management structure and application of the principles of wetland conservation. While these tasks are a matter for the national authorities in each country, national and international NGOs - and of course the Ramsar Bureau - can provide support and assistance in reaching these goals.

The need for international cooperation is graphically illustrated by UNEP's figure of 47% of the world's land area occurring in international water basins. International conventions must work together more closely, so as to achieve synergy, and not duplication, between their operations. This will require not only better coordination between convention secretariats, including joint programming and exchanges between subsidiary bodies such as scientific councils; it will also require a unified approach to the conventions at national level, with greater consultation between national focal points and coordinated reporting to the different conventions. There is a need to ensure integrated application at national level, so that conventions are treated as a complete and effective arsenal of measures for environmental conservation and not as a series of unrelated instruments. Above all, there is a need, in the case of Contracting Parties which are developing countries or in transition, to ensure that funding is available for the execution of obligations accepted under international conventions.

In addition to the general need for cooperation between international conventions, specific cooperation on wetland issues must be promoted. Ramsar needs to work with the Framework Convention on Climate Change to assess the effect of climate change on wetlands; with the Convention to Combat Desertification (since loss of wetlands is after all what often leads to desertification), and with the Convention on Migratory Species, to guarantee that adequate wetland habitat is conserved for migratory waterfowl, fish and other migratory wetland species.

Above all, Ramsar needs to coordinate its action with the Convention on Biological Diversity (CBD). After 25 years, Ramsar brings with it a wealth of tried and tested technical mechanisms and experience, while the Ramsar Strategic Plan defines a series of concrete actions designed to achieve conservation and wise use of wetland biodiversity worldwide. Wetlands could be seen as a microcosm of the application of the CBD. The second chapter presents the many common points between the general provisions of the CBD and the requirements specific to wetlands under Ramsar; it is clear that there are many areas where joint action could profitably be undertaken. The application of the Ramsar principles of listed sites (as the crown jewels of wetland biodiversity) and wise use (as the means of controlling exploitation of these natural resources so that their use is sustainable) could serve as an example and a test case for conservation and wise use of natural resources in other biomes and ecosystems. To achieve this aim, the Ramsar Bureau and the Secretariat of the Convention on Biological Diversity have signed a Memorandum of Cooperation, and the Third Conference of the Contracting Parties to the CBD has included wetlands on its

agenda, using a specially commissioned report. The basis for cooperation between the two conventions is therefore well in place.

Wetlands and tropical rain forests are generally considered to be the most threatened ecosystems on our planet. As wetlands continue to be degraded and destroyed, Ramsar will be increasing its efforts to work in collaboration with other conventions, with national and local governments, and with NGOs, to meet the challenges of the next century and ensure that wetland biodiversity is conserved in perpetuity for the use and enjoyment of future generations.

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