Biological Conservation:
Orangutan-Rattan Relationships in Indonesian Borneo

ELKE ROSALEEN MEYFARTH

A thesis submitted to the Faculty of Environmental Studies
in partial fulfillment of the requirements
for the degree of

Master in Environmental Studies

Graduate Programme in Environmental Studies
York University
North York, Ontario

April 1999

0-612-42577-0

Biological Conservation and the Importance of Biodiversity:
A Study of the Orangutan-Rattan Relationship in Indonesian Borneo

by Elke Meyfarth

a thesis submitted to the Faculty of Graduate Studies of York University in partial fulfillment of the requirements for the degree of

MASTER IN ENVIRONMENTAL STUDIES

ABSTRACT

The objective of this thesis is to investigate an interspecies relationship threatened by deforestation and human exploitation from the perspectives of biological conservation and biodiversity. A three-month study of the ecological impact of reintroduced orangutans on rattan populations revealed that (i) rattans are an important food source for orangutans, (ii) orangutan predation causes damage to rattans, and (iii) rattans appear able to recover from the most frequent form of orangutan damage. The primary goal of investigating the relationship between orangutans and rattans is to provide knowledge to benefit and improve current wildlife and botanical conservation efforts.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Dr. Anne Russon, for without her expertise, support and friendship this thesis would not have been possible. I would also like to thank my family for encouraging me to reach for my dreams, and Matthew O'Hara for his constant love and understanding.

I would like to thank everyone at the Wanariset Orangutan Reintroduction Project for all the help during my time in Kalimantan. I would especially like to thank the characters of the Sungai Wain Forest- namely Siti, Paul, Panjul, Judi, Enggong, Tuti, Charlie and Mojo, for opening my eyes to a new world. And thanks of course to my human friend in the forest, Gabriella Fredikssson, without whom I would never have survived the endless sweeping.

Thanks also to my wonderful advisors, Paul Wilkinson and Ray Rogers, for making my time at FES that much more enjoyable. Thanks to Connie Russell for encouraging me to follow through on my interests in environmental issues and primatology, and thanks to Steve McMillan for the help with the graphics. In short, thanks to everyone who helped me along on this most wonderful of journeys…

FOREWORD:
RELATION OF THESIS TO MES PLAN OF STUDY

This thesis fulfils in part the requirements for the degree of Master in Environmental Studies and represents the synthesis of the learning strategies that form the basis of my MES Plan of Study. The area of concentration put forth in my Plan is biological conservation and, as such, the objective of this thesis is to highlight the importance of biological conservation through the investigation of an interspecies relationship threatened by deforestation and human exploitation in Indonesia. The components of my Plan of Study are: environmental thought, biological conservation, and primate ecology. Each of these components is addressed throughout the course of this thesis with each learning objective having been fulfilled during the preparatory and field research involved in the completion of the thesis.

The experience of conducting research in an Indonesian rainforest brought me far beyond the world of academia and introduced me to the harsh realities of nonhuman primate conservation as it works in the real world, thus greatly expanding my knowledge of the complexities involved in running a wildlife conservation project. My chosen learning quadrant is "Intervention in Theory" and the examination of said "real world" situation strengthened my belief in the need for an alternate approach to wildlife conservation- a perspective that is well reflected in my thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Witness

I want to tell what the forests
were like

I will have to speak
in a forgotten language

W.S. Merwin

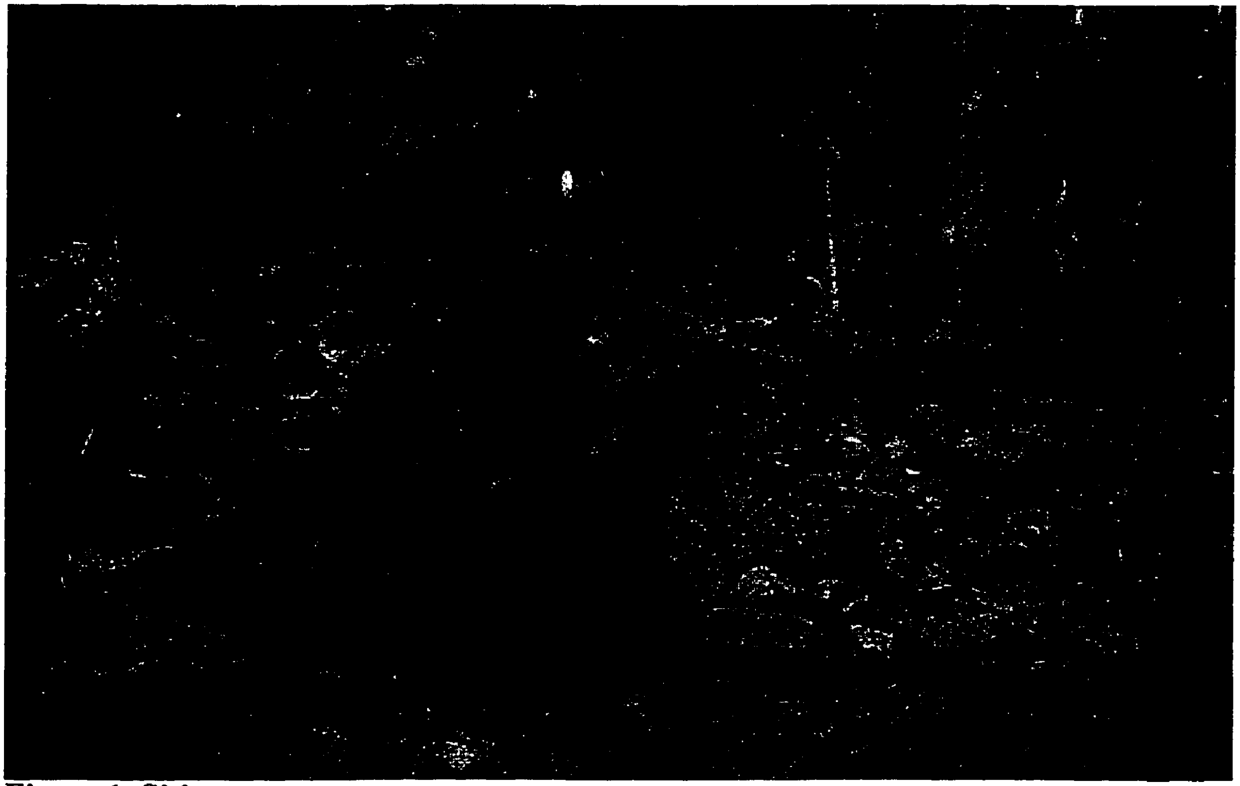


Figure 1. Siti
Photo: Elke Meyfarth

CHAPTER ONE: INTRODUCTION

The orangutan is an endangered species whose existence in the wild is threatened by deforestation and human exploitation (Rijksen 1995). It is critical to the orangutan's survival that suitable habitat is protected, and one of the most important factors in identifying suitable habitat for the orangutan is food availability (Sugardjito 1995). One known food source for orangutans are rattans, climbing spiny palms, yet many species of rattans are themselves endangered by deforestation and human exploitation (Caldecott 1988, Dransfield and Manokaran 1993). By investigating the ecological impact of reintroduced orangutans on rattan populations, I hope to gain knowledge which will benefit both orangutan and rattan conservation programs. In order to accomplish that objective, this study will provide data on the role of rattans in orangutan diets (i.e., frequency of rattan consumption, species and parts consumed, growth stage of the plants involved, orangutans' methods for obtaining rattans, type and degree of damage inflicted) and the impact of orangutans on rattans (i.e., rattan recovery post-damage).

The purpose of this thesis is first and foremost to provide vital information about the relationship between orangutans and rattans in order to improve current wildlife and botanical conservation efforts. On a larger scale, I plan to use the orangutan-rattan relationship as an example of the importance of biodiversity[i] and the need for further integrated forest research. The world's rainforests are disappearing at an alarming rate and with their loss comes the loss of valuable ecosystems and countless species (Hurst 1990, Vandermeer and Perfecto 1995). Humans are destroying the forests in the name of economic development and the destruction is occurring at such a pace that the forests are being lost before their true ecological value has been properly recognised or understood (Lammerts van Bueren and Duivenvoorden 1996). By examining the relationship between orangutans and rattans, both threatened by deforestation and human exploitation in Indonesia, I hope to share knowledge that may lead to a better understanding not just of orangutans and rattans but also of the forest within which they live.

However, ecological knowledge alone will not save the world's remaining forests. If the forests are to be protected from further destruction, it is essential that humans change the way in which they view Nature[ii]. A better understanding of forest ecology cannot halt deforestation without the political support necessary to implement the changes required as per that new understanding (Meyer and Helfman 1993). As long as forests are regarded as resources for human use, they will be at risk of exploitation. Biological conservation is a normative, multi-disciplinary call for a new understanding of the world in that it recognises and respects the inherent value of Nature in and of itself (Wilkinson 1998). Ultimately, I hope that this thesis will highlight the importance of biological conservation and the difference that its adoption could make to the survival of the world's forests.

Outline

Chapter Two will explain the importance of biodiversity and introduce the concept of biological conservation. Indonesia will be used as an example of a country that has seriously degraded its environment in the pursuit of financial wealth. The end result of the heavy resource extraction that built Indonesia's economy has been massive deforestation with both national and global consequences. Indonesia's tropical rainforests are being destroyed at an alarming rate, as are many unique species.

Chapter Two will also introduce orangutans and rattans, and explain why they are the focus of this thesis. The orangutan is perhaps the best known of Indonesia's endangered species. Many species of rattans are also in danger of becoming extinct. The investigation of their relationship provides information useful for the protection of both and for the protection of a healthy forest ecosystem.

Chapter Three will discuss the biology, range, population, and conservation status of the orangutan. Chapter Four will discuss the biology, range, and conservation status of rattan. The huge rattan-based economy will also be examined, as it is largely responsible for many rattan species' declining numbers.

Chapter Five will introduce the body of the study. The purpose of the study is to investigate the ecological impact of reintroduced orangutans on rattan populations. In order to accomplish that goal, my plan was to collect data on orangutans' rattan consumption and, if possible, signs of rattan recovery post-damage. The data collection has been divided into two methods: one which involved following the orangutans and recording their actions, and one which involved the establishment and monitoring of a series of botanical plots.

Chapter Six will present the results of the study, and Chapter Seven will discuss the meaning and implications of the results to both orangutan and rattan conservation efforts. Chapter Eight will present a summary of the results, recommendations, and areas for future research.

CHAPTER TWO:
BIOLOGICAL CONSERVATION AND THE IMPORTANCE OF BIODIVERSITY

Introduction

Biodiversity, or the biological variability among all living organisms and the ecological complexes of which they are a part, is essential to life on Earth. yet its true significance and many of its characteristics are still unknown (Lammerts van Bueren and Duivenvoorden 1996). The preservation of biodiversity is considered to be of great importance because more species have become extinct in the last half of this century than at any other time in known history (Vandermeer and Perfecto 1995). Humans are not immune to the risk, but, unlike other species, they are both responsible for creating this environmental catastrophe and capable of halting the destruction.

In this past century, a global economy has arisen which places financial values above all others. The blind pursuit of financial wealth has lead to unparalleled environmental degradation and loss of biodiversity (Hurst 1990). Governments and corporations busy themselves with the profitable task of exploiting the world's "natural resources" while ignoring the ecological, social, and true economic costs of their short-sighted actions. Economic "development"[iii] is so universally accepted that even the dominant paradigm of conservation, meant to protect Nature from development's onslaught, has recognised its supposed inevitability (Shiva 1995). For the purposes of this thesis, conservation will be defined as "a commitment by humanity to the goal of protecting habitat and preserving biodiversity" (Barry and Oelschlager 1996.). To illustrate the wide range of meanings ascribed to "conservation", the International Union for Conservation of Nature and Natural Resources (IUCN)'s World Conservation Strategy defines it as "the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations" and this definition was supported by the United Nations Environment Programme and the World Wildlife Fund (IUCN 1980). Such models of conservation aim to protect biodiversity but for future human use and profit, and, in so doing, as explained by Livingston (1981) in *The Fallacy of Wildlife Conservation*, they fail to offer animals, plants or habitat any real protection.

In contrast to the dominant paradigm is biological conservation, a model of conservation that aims to preserve Nature for its own sake, without regard to present or future human utility. Biological conservation is a qualitative and multi-disciplinary approach to conservation that draws together such fields as environmental philosophy and conservation biology with the unifying goal being the protection, as opposed to conservation, of Nature (Wilkinson 1998). Conservation biology, described by some as a "crisis discipline grounded in the recognition that humans are causing the death of life-the extinction of species and the disruption of evolution", is often confused with biological conservation but it differs in that it is a quantitative approach practised by biologists who do not necessarily hold with the normative description given above (Barry and Oelschlager 1996). The study conducted for the purposes of this thesis falls under the definition of conservation biology as it was a quantitative study, yet it was undertaken in the spirit of biological conservation and its goals are to protect both orangutans and rattans from human exploitation.

Importance of Biodiversity

As biodiversity is such an all encompassing concept, it is difficult to fully appreciate its importance. Humans understand very little of the world's many species and ecosystems: of the approximately 14 million species estimated to inhabit the Earth, only 13% have yet been described by scientists (Suplee 1995). Biodiversity is often confused with Nature itself, but it is actually one of the characteristics of Nature and it contributes to determining the values of the different functions that Nature fulfills (Lammerts van Bueren and Duivenvoorden 1996). These functions are commonly defined in terms of their capacity to satisfy human needs, but they remain vital regardless of human interpretations. Biodiversity has been described as a "life support system" in that it is required for the recycling of essential elements such as carbon, nitrogen and oxygen; it provides food, energy, and medicine; and it protects watersheds, mitigates pollution, and buffers against excessive variations in weather and climate (McNeely et al. 1990).

Tropical Deforestation and the Loss of Biodiversity

In recent years much of the global attention paid to biodiversity has focussed on tropical rainforests. Tropical rainforests have been referred to as the "genetic storehouses of the planet" as they contain so many different species (Hurst 1990:xii). They are richer in species and more complex in dynamics and structure than any other ecosystem (Lammerts van Bueren and Duivenvoorden 1996). They are thus extremely important in terms of biodiversity and have been the subject of much research and publicity (Primack and Lovejoy 1995).

Over the past decade, the global community has become increasingly aware of the environmental crisis of deforestation. All around the world, forest ecosystems have been destroyed in the name of economic "development" as short-term profits overshadow the great importance and necessity of these ecosystems (Hurst 1990); by most accounts, they still are. According to a recent report, two-thirds of the world's original forest cover has been destroyed and 94% of the remaining forest is unprotected (World Wildlife Fund 1998). Tropical rainforests in particular are disappearing at a rapid pace of approximately 500,000 square kilometres per year (Vandermeer and Perfecto 1995). Tropical rainforests are of immeasurable value, yet "developing" countries are short-changing themselves and their future by selling off rainforests as mere timber. Loss of rainforests has serious ecological effects including loss of biodiversity, loss of soil fertility, and contribution to global warming; it also has serious social effects in the form of declining land productivity and loss of potential forest-based production (Barrow 1995; Pearce and Brown 1994).

Tropical rainforests are found in Asia, Africa and America, and they currently cover a combined area of approximately 7.8 million square kilometres[iv] (Vandermeer and Perfecto 1995). In 1994, the World Resources Institute reported that Asia was covered with approximately 2 million square kilometres of tropical rainforest and had the highest annual rate of deforestation at 0.22 million square kilometres (Vandermeer and Perfecto 1995). As almost 85% of Southeast Asia's annual deforestation occurs within Indonesia

(Barbier et al. 1994), Indonesia holds the dubious distinction of having the highest rate of deforestation in all of Southeast Asia (Rice and Counsell 1993). Indonesia possesses about 8% of the world's tropical rainforests yet 20% of all logging activities in the world occur within its borders (Jepma 1995). As such, Indonesia serves as a critical case study with which to examine the causes and effects of deforestation.

The Deforestation of Indonesia

Indonesia has been described as one of the most biologically significant areas in the world (Hurst 1990). A collection of 13,667 islands (see Figure 2), Indonesia boasts a "mosaic of natural habitats" and the "world's richest assemblage of species" many of which are endemic (Hurst 1990: 5). Of the world's known species, Indonesia contains 10% of the flowering plants, 12% of the mammals, 17% of the reptiles and amphibians, and 17% of the birds (Barber 1997). The 1996 IUCN Red List of Threatened Animals[v] contains 304 mammals and 294 birds from Indonesia (Indonesian Nature Conservation Database 1998). A few of these endangered species include orangutans, sun bears, Javanese tigers, Sumatran rhinoceroses, elephants, and dugongs.

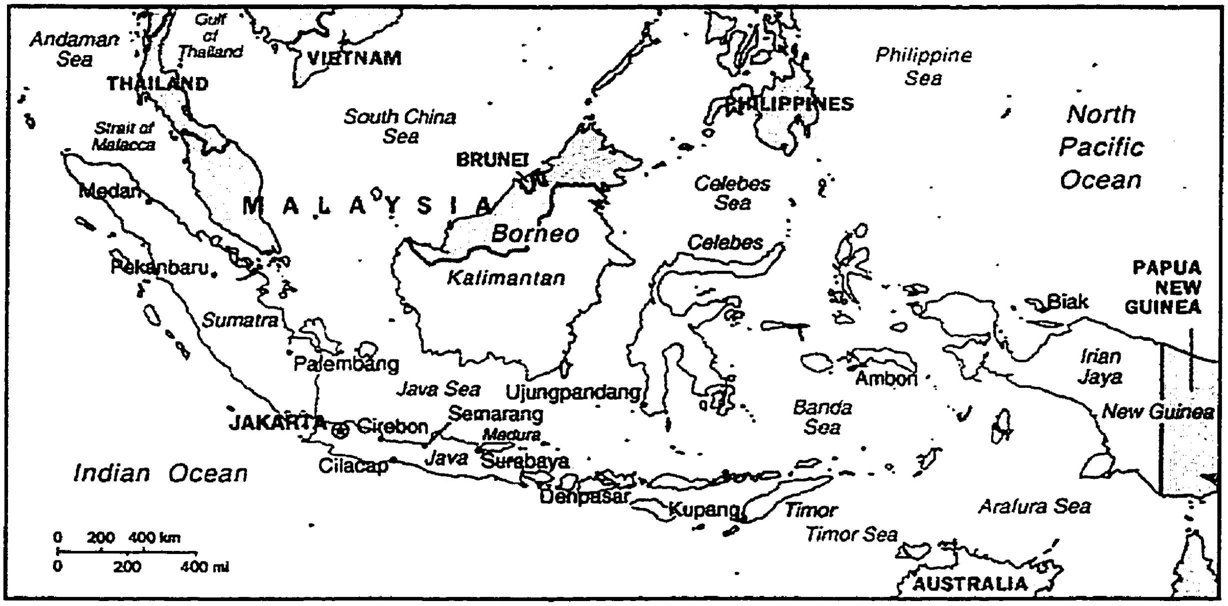


Figure 2. Map of Indonesia (Indonesia Maps Website 1998)

Indonesia is also home to over 200 million people from hundreds of different ethnic groups; the population is expected to reach 318 million by the year 2050 (Indonesian National News Agency 1998). Until the economic crash which started in 1997, the Republic of Indonesia was the strongest economy in Southeast Asia, a position it had achieved over the course of the last five decades by exploiting its natural resources (National Development Information Office 1992). The "New Order" government brought to power by Suharto in 1965 introduced a policy focused strongly on "development" that used forest resources, along with gas and oil production, as sources for internal economic development (Jepma 1995). Suharto, in fact, referred to himself as *Bapak Pembangunan* or "Father of Development" (Barber 1997).

The government today, led by Suharto's close ally Habibie, remains strongly committed to economic development and has continued the exploitation of the country's forests (World Bank Group 1998). The majority of deforestation in Indonesia is thus caused by the timber industry, followed by the government's massive transmigration scheme, conversion of forest to plantation agriculture, and, to a lesser extent, shifting agriculture (Barbier et al. 1994; Colchester and Lohmann 1993; Hurst 1990; Vandermeer and Perfecto 1995). These factors have put an enormous pressure on Indonesia's remaining tropical rainforests and, unless prompt action is taken, it is only a matter of decades before they will disappear entirely (Hurst 1990).

The Timber Industry

As of 1992, almost 145 million hectares of Indonesia's total landmass of 195 million hectares was categorised as forest land, thus making it more richly forested than any other country in Southeast Asia[vi] (National Development Information Office 1992). The timber industry has grown rapidly in recent decades and processed wood products are currently Indonesia's largest foreign export after oil and textiles (Brookfield et al. 1995). A 1985 government ban on raw log exports, in favour of local processing, temporarily decreased Indonesia's timber exports as a whole but the ban was lifted in June of 1992, in favour of imposing heavy duties on foreign sales, and it is expected that exports will continue to rise (Brookfield et al. 1995). Even without an increase, the World Bank estimated that at the 1990 rate of commercial production, Indonesia's forests would be exhausted in about 40 years (Hurst 1990).

The government of Indonesia declares itself to be deeply concerned about preserving some of their forest lands and, as such, the country has an impressive set of rules and regulations designed to ensure the sustainability of forest resources (National Development Information Office 1992). Unfortunately, these rules are rarely enforced. While the policies are premised on forest officials actively managing the forests, the ratio in the field of forestry staff to hectares of forests is so low that the "capacity of the Ministry of Forestry even just to monitor what is going on in the moist forest is minimal." (Potter 1996:16)[vii]. Then Forestry Minister Djamaludin Suryohadikusomo was quoted as saying that 90% of the raw materials used in Indonesia's timber industry (second to oil and gas as the largest source of foreign exchange) came from virgin forests, the government was not able to enforce logging regulations, and that concession holders frequently logged outside of their designated areas and violated regulations because of the lack of supervision (ABC News 1997). The rate of timber extraction (including estimates of illegal logging) has even recently exceeded the assumed rate of regeneration, and the combination of poor logging practices with inefficiency in the wood processing industries results in the waste of one third of the sustainable harvest (World Bank Group 1994).

Deforestation in Indonesia, as in other Southeast Asian countries, is different from the situation in other critical areas such as Africa and the Amazon in that the logging itself is the major cause of deforestation (Bevis 1995). Logging within Indonesia is supposed to follow a set of guidelines for commercial selective cutting. The Tebang Polih Indonesia, Indonesia's selective felling system, was established to insure that timber companies only cut trees over 50cm in diameter at breast height, that they leave a minimum of 25 trees of 25-49cm in diameter at breast height intact on each hectare logged, replant if less than 25 trees remain, and wait a period of 35 years before recutting (Hurst 1990). However, timber companies did not abide by this system (Rice and Counsell 1993) and, even if they did, the Tebang Polih Indonesia does not rest on a sound ecological basis (Hurst 1990). Mechanical logging, in both clear-cutting and selective forms, has a devastating effect on forests. In an area such as East Kalimantan, the selective removal of 14 trees per hectare has been shown to cause damage to 41% of the remaining trees and also high erosion rates, soil compaction from heavy machinery and logs, loss of nutrients, loss of wildlife and wildlife habitat, changes to the microclimate of the forest and, through the loss of the best specimens of commercially desirable species, results in genetic erosion (Adams 1990).

The establishment of logging roads opens up previously inaccessible areas and thus, along with the logging, forests are damaged by hunting and resource extraction. Exploitation of rattans, for example, is associated with road construction by the timber industry (Grieser Johns 1997). Orangutan populations are also put at risk. The more accessible the area, the more rapidly orangutan populations disappear, as they can be decimated by even a slight increase in hunting (Sugardjito 1995).

Timber industry practices also have a serious social impact that in turn leads to further environmental degradation. When the government grants huge logging concessions to timber companies, they do so without concern for the land rights of the people living in the area (Potter 1996). Indigenous peoples are forced from their land and their way of life. The Indonesian government portrays tribal peoples as being "backwards" and in need of "development" but their main goal in "developing" these people is the mass assimilation of Indonesia's many cultures into one dominant Javanese way of life (Colchester and Lohmann 1993).

Indonesia's Population Resettlement Programme, under the control of the Department of Agriculture, aimed to prevent damage to commercial forest resources, protect forests in general, and "develop" forest areas, and in the past it has used these aims as justification for forcibly "settling" tribal groups onto permanent farm sites (Hurst 1990). These forced resettlements tend to be socially destructive; they also fail to protect the forests. In some instances, as with the Dayaks of the Apo Kayan in East Kalimantan, land use after forced resettlement actually became more extensive and destructive due to the introduction of chainsaws and outboard motors (DiCastri et al. 1981). Traditionally, ladangs (small temporary farming sites) were established in secondary forest, but the introduction of chainsaws led some groups to cut much larger ladangs in primary forest and, after depleting the accessible primary forest, they cut and burned young secondary forest. The introduction of new technology and economic values helped transform what was a sustainable and low impact usage of the forest into a destructive practice that decreases soil fertility, species diversity, and the ability of the forest to regenerate (DiCastri et al. 1981).

The Transmigrasi Project

The Dutch colonial rulers initiated transmigration in Indonesia in 1905 as an attempt to relieve both over-crowding and political pressure on the island of Java, and transmigration has continued to various degrees throughout the century (Hurst 1990).

Between 1970 and 1986 the massive Transmigrasi Project was promoted by the Indonesian government as a means of improving population distribution, providing land for the "landless" of Java, fostering development on the outer islands, and improving national stability and integration (Hurst 1990). To this end, large numbers of people were moved from the highly populated areas of Java, Madura, Bali, Lombok, and Flores to the less populated outer islands of Sumatra, Kalimantan, Sulawesi, Maluku and Western New Guinea (Colchester and Lohmann 1993). Between 1970 and 1988, 4.7 million people were officially resettled (Charras and Pain 1993) and the World Bank estimated that unofficial migrants outnumbered official ones by two to one (Colchester and Lohmann 1993). Transmigration has had a huge impact on the outer islands, but very little impact on the overpopulated inner islands such as Java, where the population has continued to rise dramatically and is now over 120 million (Indonesia National News Agency 1998).

The transmigration programme failed to achieve its stated goals and, instead, served to cause suffering and poverty both for the transmigrant settlers and the people living in the recipient areas (Colchester and Lohmann 1993). Indonesia's population imbalance cannot be solved by simply moving people from one location to another (Hurst 1990). Also, site choice for the Transmigration Project was consistently poor (Hurst 1990). Despite repeated warnings from soil experts and development consultants, vast areas of land unsuitable for clearance were given over to the Project. The Transmigration Ministry cleared sites as large as 15-20,000 hectares on lands that were unsuitable for agriculture and, as of 1990, an estimated 500,000 hectares of transmigration sites were located on inappropriate forest soils (Hurst 1990). Between 1979 and the late 1980s, an estimated one million hectares of forest land was converted to agricultural land for the transmigrant settlers (Jepma 1995).

Although the government blames indigenous peoples for destructive shifting agriculture, it is in fact the translocated settlers who cause the most damage. Javanese transmigrants arrived to discover that they had been allocated land inappropriate for the Javanese rice cultivation with which they were familiar, and so they either had to find work off-site, practice a crude form of shifting cultivation in imitation of local people, or abandon the site altogether (Brookfield et al. 1995). The arrival of the transmigrants also had a negative impact on the culture and customs of the people already living in the area, further escalating the environmental destruction:

> The discrediting and undermining of customary land tenure plays an important part in many of these mechanisms of forest destruction. Breaking people's customary ties with and hold on land helps make both land and people available for use in development- in particular, in the resource exploitation into which Indonesia has been prodded by international agencies, by Northern corporations and consumption, and by its own elite.... those displaced, if not put to work on forest-destructive development projects, are often driven to clear large areas of forest for cultivation or in turn to displace others. Many transmigrants, in addition, serve as the advance guard of Javanese expansionism, disrupting traditional systems of land and forest use and conservation. (Colchester and Lohmann 1993:231).

People without a connection to land find it easier to abuse it (Evernden 1993, Livingston 1994) and the transmigration and enforced displacement practised by the Indonesian government has succeeded in alienating both the transmigrants and the local people from their land. The result has been widespread environmental degradation.

The official transmigration programme stopped in 1986 due to the high costs of financing the programme, the growing criticism from environmental groups, an increasing "reluctance" of donors to support the programme, and a lack of suitable sites (Charras and Pain 1993, Jepma 1995). While the official transmigration has ended, there is still a continuous flow of migrants joining families who were officially resettled:

> It had grown to such a scale and importance that it outstrips the official schemes in area, in population, and also in productivity. One of the consequences of the spontaneous land colonisation is that the process has become rather unmanageable, and increasingly creates conflicts either between the forest authorities and the spontaneous settlers, or even between the forestry administration and the state directed land-clearing schemes. Ethnic and cultural pluralities tend to aggravate any frictions on land. (Uhlig 1994 as cited in Jepma 1995:108).

Both the Ministry of Transmigration and the World Bank, which previously helped fund the Transmigration Project, were supportive of what they termed "spontaneous agricultural settlement" (Charras and Pain 1993: 20) and, thus, the transmigration and subsequent deforestation continued, albeit unofficially.

Conversion of Forest to Plantation Agriculture

Large areas of forest land have been "converted" to plantation agriculture, ostensibly to feed a rapidly growing population. In recent years, more than 6 million hectares of lowland forest were cleared to allow for the production of palm oil, rubber, cocoa and coconut oil in Southeast Asia (Hardter et al. 1997). The conversion of logged over areas of primary forest to agricultural plantations results in a permanent loss of forest habitat (Leiman and Ghaffar 1996). The conversion of forest to plantations in

Kalimantan has destroyed vast tracts of orangutan habitat and, in at least one plantation, a bounty was placed on orangutans in an attempt to protect young oil palms (Rijksen 1995).

The largest forest conversion project, the "One Million Hectare Peat Reclamation Project" initiated by Suharto in 1995, sparked immediate international condemnation for its poor planning and terrible site choice (Junaid 1997, Muntingh 1997, South East Asian Policy Advisory Network 1998). Despite the negative recommendations of an environmental impact assessment, the Indonesian government proceeded with the project and hundreds of thousands of acres of peat-swamp forest in Central Kalimantan were cleared for the establishment of rice paddies (Anonymous 1998). According to the International Peat Society, it is not possible to grow rice economically on deep peat and the productivity of other crops is also low compared to growing on mineral soils (International Peat Society 1997). Large amounts of herbicides and pesticides are required, as is the construction of elaborate peat-draining channel systems (IRIP News Service 1998). The mega project uses approximately 2.4 million litres of pesticides a month, the most important and hazardous of which is paraquat, a pesticide illegal everywhere else in Kalimantan but used by the mega project with special permission from the Agriculture Minister (Inside Indonesia 1997). Indonesia was unable to win international funding for this project so the government has funded it instead with money from the Reforestation Fund, a fund consisting of mandatory fees paid by forest concessionaires for the official purpose of replanting trees. The clearing of over one million hectares of peat-swamp forest for the project conveniently provides the logging industry with an estimated double the supply of timber in Indonesia over the first three years of the project (IRIP News Service 1998).

The mega project has already destroyed vast areas of wildlife habitat, notably of orangutans (Muntingh 1997). Thousands of acres of Dayak rattan gardens have also been destroyed (Secreteriat Kerjasama Pelestarian Hutan Indonesia SKEPHI/ NGO Network for Forest Conversion in Indonesia 1998). The destruction of the peat-swamp forests brings not only the loss of a unique ecosystem but also increases flooding, erosion, and carbon emissions (IPS 1997). Dry peat burns exceptionally well and cleared peat lands are subject to extensive and long-lasting fires, as was made evident by the recent fires of 1997 and 1998. In March of 1998, 27 non-governmental organisations world-wide asked the International Monetary Fund and the World Bank to intervene during emergency loan discussions with Indonesia and halt further activities in this massive peat-swamp conversion, but their open letter was ignored (SKEPHI 1998, Webber 1998). On April 2, 1998, the European Parliament adopted an urgent resolution, in response to widespread forest fires in Indonesia, which urged the Indonesian government to "stop activities in the framework of the Mega-Rice Project on Kalimantan" but this too was ignored (SKEPHI 1998). President Suharto resigned on May 21, 1998 (World Bank Group 1998) and hopefully the post-Suharto government will choose not to continue with this project.

Shifting Cultivation

One of the stated goals of the Transmigrasi Project was to foster "development" of the outer islands; to the Indonesian government, this involved eliminating the traditional shifting agriculture practised by indigenous peoples. Shifting cultivation can refer to many different methods of farming, but the common factor is "reliance on natural regeneration of capability under fallow as a major element in management" (Brookfield et al. 1995). As practised in its pure form, the biomass is allowed to recover to the level at which it will permit, after clearance, as good a harvest as the previous one (Brookfield et al. 1995). The effects of such shifting agriculture can hardly be compared to the massive destruction wrought by large timber companies, yet the Indonesian government has declared shifting agriculture to be illegal and damaging to the environment.

The Indonesian government has also scapegoated peasant farmers and woodcutters for causing deforestation (Hurst 1990). While slash and burn agriculture, pepper plantations, and woodcutting do cause environmental degradation, it is on a far smaller scale than the destruction wrought by the timber companies. Also, most of these activities occur in areas already logged-over, so it is inaccurate to blame the ultimate destruction of the forest on those who chop down the last few trees. According to Ewel (1978), "to say that deforestation results from the action of the peasant farmers is analogous to saying that the vulture which struck the lethal blow killed the dying horse" (quoted in DiCastri et al. 1981:119). However, this does not absolve peasant farmers from all blame because their actions are still contributing to deforestation. A 1980 estimate found that shifting agriculture in East Kalimantan had created 2.4 million hectares of secondary forest and 0.4 million hectares of grassland, which amounted to 16% of the total forest area at that time (Adams 1990). The tall, fire-resistant Imperata or *alang-alang* grass that dominates such grasslands is extremely difficult to remove and is considered useless for grazing.[viii]

By 1989, Imperata grass had spread to cover more than 20 million hectares of Indonesia (Hurst 1990).

Constraints to Halting Deforestation

The largest constraint to halting the rapid deforestation of Indonesia is its corrupt government whose large investment in the timber industry has led to an obvious conflict of interest. In order to maintain control of timber investments after the initial rush of foreign investment in the 1970s, many retired government and military personnel became involved in the timber companies and political favours were involved in the allocation of timber concessions (Hurst 1990). Despite the resignation of President Suharto, the decision-makers of Indonesia remain a small and tightly knit group who cannot be expected to make unbiased decisions regarding the regulation of forestry practices.

> Economic activity is dominated by a dense, intensely personal network of public monopolies, private cartels, and bureaucratic fiddles. Foremost among the protected industries is the forest products area. Here the President's closest friends and family have long ago secured (and continue to amass) incredible fortunes through what are, to all intents and purposes, unregulated logging practices, protectionist policies, favouritism, nepotism, corruption, etc. No Indonesian environmental formulation- or implementation and formulation thereof- in the forestry area is done without a handful of selected businessmen. The main obstacle to reform in this area is, therefore, a lack of political will. (Petrich 1993 as quoted in Brookfield et al. 1995:108).

Unless Indonesia experiences a profound change in its power structure, it is doubtful that any positive changes to the timber industry will come from above. The government justifies the continued exploitation of the forests in the name of economic development, and also in support of its transmigration scheme and its conversion of forest land to agricultural land to feed the country's rapidly rising population. These excuses do little to mask the true reasons behind the environmental destruction. There is simply too much money to be made, and so long as it remains profitable to plunder the forests, the powerful elite of Indonesia will continue to do so.

Another major constraint to halting the deforestation of Indonesia comes in the form of multinational corporations who are more than willing to take advantage of "developing" countries. It will be extremely difficult to convince Indonesia to adopt more ecologically sound forestry practices when so-called "developed" countries such as Japan, Canada, and the United States are offering them vast sums of money to exploit their natural resources. If not for these unscrupulous investors, there would be much less reason for countries such as Indonesia to recklessly exploit their resources and much less room for the kind of corruption that dominates the Indonesian timber industry.

Species at Risk in Indonesia: Orangutans and Rattans

As orangutans live in tropical rainforests, the massive deforestation occurring in Indonesia has dramatically shrunk both the orangutan population and its range to the point that orangutans are an endangered primate species reduced to scattered populations on the islands of Borneo (which, in addition to the Indonesian province of Kalimantan, includes the Sultanate of Brunei and the independent Malaysian states of Sarawak and Sabah) and Sumatra. Identifying and protecting suitable habitat for orangutans is critical to their survival in the wild. One of the most important factors in determining an area's suitability for orangutans is food availability (Sugardjito 1995). Orangutans consume a wide variety of foods and this variety is essential for their survival within the complex tropical rainforest ecosystem. Whether it is the rainy season, the dry season, or a period of drought, there must be enough food available to sustain the orangutans within their range. Rattans, a subfamily of climbing spiny palms, are important foods for orangutans, yet many species of rattan are themselves endangered by deforestation and human exploitation (Johnson 1996). In recent times, rattans have been the most widely used non-timber forest product in South East Asia and they have been harvested on a scale second only to the timber industry (Mabberly 1992). The demand for rattans (which are used largely to make furniture and wicker handicrafts) is exceeding the supply (Kartinawata et al. 1983, Peters 1996) and many of the commercial species most in demand are being pushed towards extinction (Siebert 1991).

Orangutans and rattans share the same forest habitat and the same threat of extinction from deforestation and overexploitation. Various groups of scientists, wildlife conservationists, and botanists are involved in researching and/or protecting one or the other, yet no studies have been done on the relationship between the two and the role they play within the forest ecosystem. It is essential to study endangered species as they relate to each other if humans are to effectively identify and protect suitable habitats.

Rattan extraction is currently being promoted as a more sustainable alternative to the logging of timber, yet much remains to be discovered about the role that rattans play within tropical rainforest ecosystems. In particular, little is known about the impact that rattan harvesting might have on species such as the orangutan who[ix] depend on rattans.

There is also little known about the impact that these species might have on human intentions to harvest rattan crops and so it is also important to assess the impact of orangutan predation on rattans in order to better understand the orangutan-rattan-human relationship. It would therefore be very useful to investigate orangutan-rattan interactions so as to be able to make informed and effective decisions regarding orangutan conservation and "sustainable" development alternatives.

Orangutans and humans are in direct competition for the same resource. Both orangutan conservation programs and "sustainable" development programs need to be aware of the importance of rattans to orangutans so that they can make effective planning decisions in regards to forest use. For example, the adoption of an "integrated use" policy[x] in an orangutan-inhabited forest would prove problematic as humans would then be competing directly with the orangutans for what is, to both, a valuable resource. The advocation of rattan harvesting as ecologically benign has been premature (Peters 1996) and, therefore, it would be wise to gather as much information as possible about the ecological impacts that rattan harvesting has on the entire ecosystem, especially on species, such as the orangutan, who have an important relationship with rattans.

For these reasons, the focus of this thesis is an investigation into the relationship between orangutans and rattans which examines the ecological impact of a population of reintroduced orangutans on a rattan population. Before entering into the details of the study, it is necessary to develop a basic understanding of both orangutans and rattans. As such, Chapter Three will discuss the biology, range, population, and conservation status of orangutans and Chapter Four will discuss the biology, range, population, and conservation status of rattans.

---

[i] A 1992 United Nations Environment Programme Convention on Biodiversity defined biodiversity as "the variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems" (Abang Morshidi and Gumal 1995: 205).

[ii] For the purposes of this essay Nature is defined as "life phenomena that are not human" (Livingston 1994:7).

[iii] The term "development" has come to be synonymous with economic growth. It refers to a sustained increase in per capita income and is based on growth of the market economy. It does not take into account nature's economy or people's survival (Shiva 1992).

[iv] Given the high rates of tropical deforestation, this number would be significantly less today.

[v] The 1997 IUCN Red List of Threatened Plants has just been released but was not publicly available at the time of this writing.

[vi] It is important to note that this figure is likely exaggerated: land often remains "forested" on official maps long after it has been deforested in reality. According to an independent forest consultant, the figure provided by the Indonesian government includes land which has already been degraded or destroyed as a result of logging, plantation agriculture and the Transmigration Programme (Myers 1989).

[vii] The following quote from 1990 gives an idea of the difficulties managing forestry practices at that time; the situation is not much improved today: "The sector of the Indonesian state that deals with forest and implements forest policy is large and highly centralised. There are the Ministry of Forestry in Jakarta, regional offices, provincial forestry services and state-owned forestry corporations. They all report directly to the Minister and are basically under the Minster's control. Government policies are premised on forest officials in the field managing the forests, but the ratio in the field of forestry staff to hectares of forests is 1:314,000 in East Kalimantan, roughly 1:120,000 elsewhere in Indonesia, except Java" (GOI/FAO 1990).

[viii] There is some debate as to whether or not Imperata grassland can truly be considered wasteland, as some shifting agriculture systems create grassland deliberately for hunting purposes or to graze livestock on fresh shoots after burning, but it is agreed that the grassland ecosystem is much less productive than the original forest in terms of biodiversity, total biomass for the maintenance of soil fertility and carbon capture, and as a source of useful materials for human populations (Brookfield et al 1995:179). Recent studies (Banarjee 1995) have investigated methods of rehabilitating Imperata grasslands, including allowing natural succession to forest formation.

[ix] Having spent time with orangutans and being thoroughly impressed by their distinct personalities and amazing intelligence, I feel strongly that they be referred to as "who" rather than "which".

[x] Integrated use implies that an area will be both conserved and developed, with humans allowed to participate in "sustainable" land use practices.

CHAPTER THREE:
THE ORANGUTAN

Introduction

Orangutans are great apes and they- along with gorillas, chimpanzees and bonobos- are human's closest living relatives. Their physical resemblance to humans and their high intelligence have long made them objects of human fascination. The name orangutan comes from the Malay words *orang* meaning "people" or "reasonable being" and *utan* meaning "of the wood." It is often translated as "man of the woods," but the Malaysian language more accurately recognises that "reasonable beings" consist of both sexes (Amon 1977). Orangutans are the subject of folk tales and myths of both the humans who have lived alongside them and the Western humans who came later to "discover" them in the 16th century (Amon 1977). Despite, and sometimes because of, curiosity and interest in orangutans, their relationship with humans has been one of constant exploitation. They are used for food, entertainment, pets, and scientific studies. Over the years, the combination of losing individuals to the above uses coupled with a dramatic reduction in habitat has resulted in a serious decline in the orangutan population. (Eudey 1995, Sugardjito 1995).

Biology

Orangutans are divided into two subspecies: *Pongo pygmaeus abelii* of Borneo and *Pongo pygmaeus pygmaeus* of Sumatra. They are the largest arboreal primate, spending much of their day searching for food in the trees of their rain forest habitat.

They are primarily frugivorous (fruit-eating), but eat a highly varied diet which includes insects, leaves, shoots, flowers, bark, soils, and even meat on rare occasions (Knott 1998, Rijksen 1985, Rodman 1977). They are sexually dimorphic, with males weighing an average 77 kg and females 37 kg (Napier and Napier 1985). They have earned a reputation of being solitary animals as they spend a great deal of time alone and the most common social group is a mother and child. Adult males prefer to live alone, using loud calls to keep a comfortable distance from each other (Knott 1998).

With a 93-month birth interval, orangutans are the slowest breeding nonhuman primate (Sugardjito and Van Shaik 1992). They are described as "the ultimate K-selected species, in that survivorship is high, inter birth interval is long (mean = 8 years) and the female makes a high investment in her offspring" (Leighton et al. 1995:97). Those eight years are crucial for passing on the knowledge of how to survive in the forest. Orangutans are very sensitive to changes in their environment, so much so that their birth rate will drop as a result of nearby logging or mining even if their immediate surroundings are undisturbed. As they are so slow breeding, orangutans are made vulnerable by even a slight drop in population: an increase in adult mortality of just one percent per year will change the population from being relatively stable to declining (Leighton et al. 1995). Orangutans are currently losing far more than one percent of their population each year to habitat loss, hunting, and the pet trade, and so can be considered greatly endangered. Their range has shrunk dramatically, is badly fragmented, and is under constant pressure (Rijksen 1995).

Range

Orangutan fossils have been found which date back to over 2 million years ago. During the Pleistocene. orangutans lived throughout Southeast Asia. ranging from the southern part of China to the Great Sunda Islands. Orangutan teeth have been found in Pleistocene deposits in Java, Borneo, Sumatra, China, and Vietnam. Judging from very large Pleistocene orangutan teeth found for sale in Chinese drugstores alongside the teeth of pandas and mountain goats, it has been suggested that there also existed much larger mountain orangutans in China (von Keonigswald 1982). Orangutans continued to inhabit this wide range of habitats up until about 25,000 years ago, but over the following 10,000 years they were restricted to Indochina and today exist only on the islands of Borneo and Sumatra (Szaly 1979)(see Figure 3).

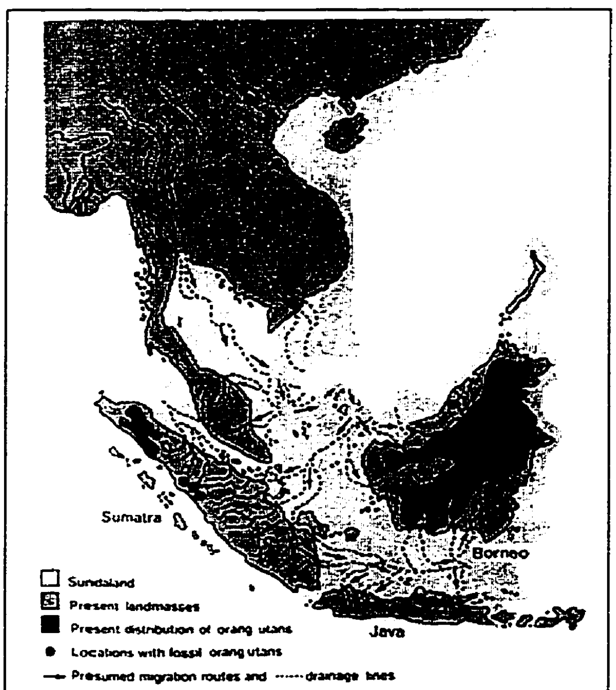


Figure 3. Map of Orangutan Range (Von Koenigswald 1982:13)

It is believed that humans were responsible for the great decline in orangutan range through overhunting: this theory is quite probable given that orangutans are the slowest breeding primate on Earth and are thus especially sensitive to exploitation (Sugardjito and Van Shaik 1992). It appears that the orangutan was hunted to extinction in all the regions where the earliest agricultural migrants from the Asian mainland settled (Rijksen 1986). Climate change has also been suggested, but this seems unlikely as the orangutans had previously lived in a wide range of environments and pandas, a regular companion, continue to exist in areas where they both once thrived (von Koenigswald 1982). Today, however, there is no doubt as to why the orangutan range continues to shrink: habitat destruction wrought by humans.

Habitat Loss

Predation by humans has been constantly reducing orangutan populations, but within the last century the situation has been exacerbated by severe habitat loss. Like other tropical rain forests, the treetop homes of the orangutans are under incredible pressure from rapidly expanding human populations. As the governments of "developing" countries follow the example and incentives of the industrialised world, vast areas of rain forest are lost in the conversion to material wealth via resource extraction. Unfortunately for the orangutan, both orangutans and humans prefer the same type of habitat. Orangutans live mainly in alluvial plains and valleys, areas that provide the highest abundance of fruit trees and lianas. Humans also prefer to live in such areas because of their rich soils and easy accessibility via rivers and streams (Rijksen 1986). Humans always win the resulting competition.

Areas opened for development quickly lead to a significant drop in orangutan numbers. In 1986, the Indonesian government opened up Kalimantan (Indonesian Borneo) to timber concessions and other forms of economic development. The resulting habitat loss and degradation, while obviously harmful in itself, also increased the orangutans' vulnerability to poaching and capture (Rijksen 1995). Infants fetch a high price in the illegal pet trade and many thousands have been smuggled out of the country or purchased by wealthy Indonesians (Eudey 1995). The skulls of adult orangutans are decorated with carvings and sold to tourists. According to a 1993 Population and Habitat Viability Analysis workshop, the overall orangutan population in Kalimantan is estimated to have dropped to no more than 12,300 to 20,571 over the brief span of time from 1986 to 1993 (Eudey 1995).

The events of the past year have put an even larger strain on the remaining wild orangutan population. Beginning in the summer of 1997 and continuing into June of 1998 (International Forest Fire Management 1998), forest fires ravaged vast areas of Borneo's remaining forests and it is estimated that at least one third of the island's forest cover was destroyed. The fires were human-caused (IFFM 1998): both the situation that made such a disaster possible and the complete lack of an effective response to the fires will be examined in the epilogue. Many orangutans were killed or displaced by the fires. It will be some time before studies of the aftermath can provide concrete figures but it is obvious that this tragedy will have a very serious negative impact on Borneo's orangutan population.

Other Threats: Hunting, the Pet Trade, and the Entertainment Industry

While the largest single threat to orangutans is habitat destruction, hunting, the pet trade, and the entertainment industry also cause significant pressure (Sugardjito and Van Shaik 1992). Charred remains of orangutans dating back 35,000 years have been found near human inhabited caves in Sarawak, suggesting that orangutans were used as a food source; it has also been suggested that at least some of these orangutans may have been kept as pets (Leiman and Ghaffar 1996). Hunting of orangutans for food continues to this day and, as orangutans are so slow breeding, it has been responsible for many local extinctions (Leiman and Ghaffar 1996, Rijksen 1995).

From the time of their "discovery" by European explorers in the 16th century, a steady stream of orangutans has been taken from Borneo and Sumatra, destined for private collections, zoos, and laboratories. During the first two decades of this century, so many orangutans were shipped out to Western zoos that the colonial rulers of the former Netherlands East Indies began to worry about the extinction of the orangutan in the wild (Rijksen 1995). In 1925, the colonial rulers of what was then called the Dutch East Indies (now Indonesia) created the Fauna Protection Ordinance (Aveling and Mitchell 1982) and the orangutan became the first officially protected mammal in Southeast Asia (Rijksen 1995). By the 1940s, a total ban on hunting and trade of orangutans and parts thereof was declared by the colonial government of Indonesia, which also set aside the first major reserves for orangutan conservation (Rijksen 1985). It should be noted, however, that these reserves were chosen not as areas representative of ideal orangutan habitat but on the basis of their not having any prospect for profitable cultivation or exploitation either due to remoteness or poor soil and terrain conditions. They covered just 20% of the Sumatran orangutan's range and less than 3% of the Bornean range (Rijksen 1985). This was, at least, a start towards the conservation of orangutans and should be seen as a credit to the colonial government, especially as the British colonial government did not establish any reserves in its section of Borneo. It is only recently that the governments of Sarawak and Sabah have set aside reserves for endangered species like the orangutan (Rijksen 1985). By the 1970s, a world-wide ban on orangutan trade was put in place (as a result of CITES: the 1973 Convention on International Trade in Endangered Species of Wild Flora and Fauna), but it is not strictly enforced by all countries.

Local people and wealthy Indonesians have long kept orangutans as pets, but it is the international pet trade that has been most damaging to the orangutan. Taiwan has been the largest recent consumer of pet orangutans, with at least 1,000 individuals smuggled out of Kalimantan for sale as pets in Taiwan between 1985 and 1990, and between 1,000 to 3,000 from Indonesia as a whole (Leiman and Ghaffar 1996, Eudey 1995). Taiwan is not a member of CITES and it was not until 1989 that the Taiwanese government passed their own Wildlife Conservation Law. Trade has now slowed down significantly, but those five years of active trade had a huge impact on the wild orangutan population. In the process of obtaining young orangutans, it is estimated that as many as three to five individuals died for each one arriving in Taiwan: a loss of over 3,000 individuals or at least 10% of the total wild population (Leiman and Ghaffar 1996). The huge popularity of orangutans as pets in Taiwan came about as a result of a popular television show that depicted an orangutan as an ideal family pet. Orangutans may seem like wonderful pets when they are young, but they quickly outgrow their cuteness and become large, extremely strong, intelligent, and uncontrollable animals as they approach sexual maturity. Many of these beloved pets are abandoned and then shot by authorities (Rijksen 1995), but a few are sent back to Indonesia for rehabilitation if their owners are able and willing to foot the hefty bill.

The media is guilty of perpetuating a cute and cuddly stereotype of orangutans, especially in North America where they are used in advertisements to sell products, in movies as comic relief, and even by conservation agencies to raise funds that do not necessarily go towards orangutan conservation (Rijksen 1995). As a result, the public holds a Disney-fied view of orangutans and an acceptance of the "right" to use them. Orangutans are portrayed as funny, friendly little jokers who love to be with humans, and are very rarely shown as strong, mature, and solitary adults. The cuteness and charisma displayed in media portrayals has lead to increased recognition of the species, but not the seriousness of the orangutans' plight.

Current Status

Current estimates of the remaining wild populations of orangutans in Borneo and Sumatra vary, but even the most generous guesses show the species to be endangered.

Over the last 25 years, there has been an 80% loss of suitable habitat and within the last 15 years, orangutan numbers have declined by 30-50% (Soemarna et al. 1995). A 1993 Workshop on Population and Habitat Viability Analysis of the Orangutan estimated that the total population in Borneo was 15,000 and in Sumatra was 5,800 (Sugardjito 1995). The PHVA workshop used a VORTEX computer simulation model and various orangutan population estimates from field biologists to arrive at these new, lower estimates of the total wild orangutan population (Soemarna et al. 1995). Estimates of total orangutan numbers vary because they are just that- estimates. Again, these numbers are now much lower following the Indonesian fires of 1997 and 1998.

According to Rijksen (1995), studies with computer models and comparisons with isolated human populations indicate that orangutans may be in danger of extinction if their numbers drop below 5,000 individuals. While these figures refer to the total population, it is important to recognise that in reality, habitat destruction has left the orangutans divided into separate and isolated populations. As these distinct populations are not in contact with each other, they should be treated as separate units (Sugardjito and Van Shaik 1992). There should also be some distinction made between protected and unprotected groups.

Efforts to Protect Orangutans

Current efforts to protect the remaining wild orangutans include protecting orangutan habitats, rehabilitating ex-captive orangutans, raising money and awareness through ecotourism, and educational campaigns.

Habitat Protection: Orangutans have been protected in reserves for decades, yet this protection is stronger on paper than in reality. On paper, at least 27,500 square kilometres have been set aside for orangutan conservation; in reality, much of this land is unsuitable for orangutan habitation and is also unprotected (Sugardjito 1995). Reserves of "pristine rainforest" were established in areas which had already been logged yet were still green on official maps, and conservation areas continued to be exploited by timber companies and local land-use programs (Rijksen 1986). It is very difficult to enforce laws protecting conservation areas in developing countries, due both to the cost of protecting boundaries and an unwillingness to put conservation ahead of what is perceived to be "development."

Putting a stop to the orangutans' population decline is as simple as stopping habitat destruction and conversion and protecting wild orangutan populations, yet these two measures are extremely hard to accomplish in the face of demands for economic development. Thus the first and most important method of orangutan conservation, namely protecting orangutans and orangutan habitat from human encroachment, is given the least amount of attention and is even considered to be outdated. Far more attention is given to other conservation efforts including orangutan rehabilitation, ecotourism, and education.

Rehabilitation: Rehabilitation is a method of wildlife conservation[i] that involves reintroducing ex-captive animals to the wild after teaching them how to survive in their natural habitat. As the number of endangered species continues to rise and animal populations continue to be displaced and destroyed, it is likely that rehabilitation will be used more and more frequently in the future. Zoos are ardent supporters of rehabilitation and use it to justify their own existence in that they claim to preserve and breed endangered species in captivity so that one day the animals can be reintroduced to the wild. Orangutan rehabilitation is costly and time-intensive (Yeager 1997). At the Wanariset Orangutan Reintroduction Project, it reportedly costs approximately US$1500 per orangutan per year for the process of rehabilitation, with the process taking up to 4 years (Balikpapan Orangutan Society/USA 1998). Some of the orangutans can never be released (due to disease, age and/or perceived inability to cope with forest life) and those who are released are by no means guaranteed a successful life in the wild because they are inadequately prepared for living independently in the forest (personal observation). Despite its shortcomings, rehabilitation remains a popular method of conservation in the eye of the general public as it gives the illusion of saving endangered animals and returning them to their rightful place. There are currently five orangutan rehabilitation centres in operation: three in Indonesia, one in Sabah, and one in Sarawak (Leiman and Ghaffar 1996).

The first orangutan rehabilitation projects were established in the 1960s with the goal of replenishing the decreasing wild population, but, as the risk of disease transmission was recognised and the success of teaching captive orangutans to become "wild" came into question, the rehabilitation centres shifted their focus to serving as educational facilities (Aveling and Mitchell 1982). Captive orangutans are still being released into the wild, but only in areas with no resident wild populations.

A new method of rehabilitation called "reintroduction" has been practised at the Wanariset Orangutan Reintroduction Project in East Kalimantan since 1991. Reintroduction involves: searching for and confiscating illegally held orangutans and bringing them to quarantine facilities at Wanariset, medical screening, socialisation and introduction to various foods available in the wild; as well as the selection of suitable release sites, security measures after the release, and research on a wide range of subjects related to the rehabilitation of orangutans (Smits et al. 1995). It claims to place more of an emphasis on the establishment of social groups than previous projects have and it also takes greater care to prevent the transmission of diseases. It is the only rehabilitation method now officially sanctioned by the Indonesian government and the first to claim to keep detailed accounts of how the released orangutans fare in the forest (Smits et al. 1995). While the Project claims that 95% of the orangutans released by the Project into the wild are now living successfully in the forest (Smits et al. 1995), this number has not been properly verified and personal observation suggests that the true number is substantially lower[ii].

Whatever the successes of rehabilitation projects such as Wanariset, the people running them are the first to admit that their very existence is indicative of a much larger problem. According to Dr. Willie Smits, head of the Wanariset Project, "The fact that we still have orangutans coming in means that we have failed" (Kuznik 1997:42).

Ecotourism: Another method suggested as a means of protecting orangutans is ecotourism[iii]. Tourists are willing to pay a lot of money to see a wild orangutan and this money could be used to encourage local people to view the orangutans as valuable resources to protect and preserve. Using the orangutan as a "flagship" species[iv], a strong local economy would arise while the forest and its resident orangutans would remain healthy and intact. While the theory is positive, the reality is not. Ecotourism, despite its lofty aspirations, is still just tourism. Ecotourists want to see animals and the odds of seeing a wild orangutan are rare. Tourists will not be satisfied unless they can bring back some sort of memento: as the trophy of choice for most ecotourists is a photograph, most will come away disappointed. Noise, traffic, garbage and simply the stress of having humans in the same vicinity all have a negative impact on wildlife populations. Nonhuman primates face the added dangers of disease transmission and decreased reproductive rates (Russell and Ankenmann 1996). For a species already on the brink, this is clearly disastrous.

Given that the odds of sighting a wild orangutan are so rare, rehabilitation and reintroduction projects are viewed as ideal sites for ecotourism as the tourists are guaranteed to see orangutans. This has led to a situation in which the orangutans in some of the rehabilitation centres have become commodities exploited in order to attract ecotourism (Leiman and Ghaffar 1996). The presence of tourists is again very negative, both for the reasons given above and because the presence of humans interferes with the goal of teaching the orangutans to become independent[v]. Perhaps the best element of the Wanariset Reintroduction Project is the lack of tourism, but Smits has been ordered by the Minister of Forestry to open Wanariset and the Sungai Wain Forest into which it releases orangutans to ecotourism (Drewry 1996).

Education: The use of education as a tool to protect orangutans comes in the form of educational campaigns mounted by orangutan protection and wildlife conservation groups and in the use of rehabilitation sites as educational facilities. There have been numerous books and documentaries featuring the orangutans' plight; recently there have also appeared several web sites that provide information about orangutans and the work being done to protect their survival (Balikpapan Orangutan Society Website, Orangutan Foundation International Website, Discovery Online- The Ape Crusaders Website). The goal of such educational programmes is to "guide individuals beyond a general awareness of conservation problems to the commitment and action that eventually will solve these problems" (Jacobson 1995:xxv). While there may be a raised awareness of orangutans amongst the general public (both in Indonesia and internationally), ultimately the power to make the decisions necessary for the orangutans' survival lies with the governments of Indonesia, Sabah, and Sarawak and the corporations with which they do business.

Despite national and international efforts to protect wild orangutans, their numbers are rapidly declining. It is evident from the brief descriptions given above that the most important and effective step humans can take to protect orangutans is to protect the orangutans' habitat, yet it is in habitat protection that efforts have been most lacking. The forests that are home to the orangutans continue to be destroyed and with their destruction comes the loss, not just of current orangutan habitat, but also the chance for humans to learn why that habitat is ideal for orangutans; thus, the chance to identify and protect areas that might be suitable for future orangutan habitation is also being lost.

Food availability is one of the most important factors defining suitable orangutan habitat, making it crucial that the orangutan diet is properly understood and catalogued. One orangutan food item that has not yet been studied is rattans. Before Chapter Five introduces the study of the relationship between orangutans and rattans, Chapter Four will discuss the biology, economy, range, and conservation status of rattans.

---

[i] "Wildlife conservation" is a term that is used by both preservationists and conservationists. At the preservation end of the spectrum are those who believe that wildlife conservation is the "preservation of wildlife and groups of forms in perpetuity, for their own sakes, irrespective of any connotation of present or future human use" (Livingston 1981:17). At the conservation end are those who believe that wildlife conservation should consist of conserving wildlife and habitat so that humans can continue to hunt, fish, and otherwise abuse various species of wildlife (e.g. Ducks Unlimited). I align myself with the preservationist camp.

[ii] The subjects of this study are orangutans released by the Wanariset Project and they are very valuable as subjects because they are easily located and followed. While the ultimate goal of rehabilitation is to enable the orangutans to live independently of humans, some of the orangutans most recently released into the forest show up frequently at daily feeding sites. The orangutans' past habituation to humans means that one can study them from a relatively close distance without greatly altering their behaviour (although sometimes their lack of fear can prove dangerous for humans who get too close). The orangutans who do not frequent the feeding sites are also usually not averse to being followed by human researchers. The records kept by Wanariset provide the researcher with release dates, approximate ages, and basic medical and personal information about the orangutans.

[iii] Ecotourism, an oxymoron along the same line as sustainable development, is proposed as a means of both protecting local ecosystems and developing local economies. Recent forms of ecotourism (active ecotourism, participatory ecotourism) strive to achieve a balance between environmental, social, and economic concerns, but most forms of ecotourism are not ecologically, socially, or economically sustainable (Drewry 1996).

[iv] The term "flagship species" refers to charismatic species that are used to draw attention, funding and ultimately protection to an ecosystem; but by highlighting "endangered" species they obscure the fact that *all* species are currently endangered by the actions of humankind.

[v] Rachel Drewry (1996) has written a detailed study of orangutan ecotourism in Indonesia that provides further insight into these issues.

CHAPTER FOUR: RATTANS

Introduction

Deforestation of the world's tropical rainforests is currently a major environmental concern. One of the suggestions put forward to halt this destruction is to switch from harvesting timber to harvesting non-timber forest products. Rattans, the name given to a subfamily of over 600 species of spiny climbing palms, are currently the most widely used non-timber forest product in Southeast Asia (Dransfield and Manokaran 1993). The rattan trade has existed for centuries, but it has only recently been commercialized. Rattan cultivation is promoted as an ecologically sustainable way to "improve income and quality of life for subsistence farmers in South East Asia and take pressure off the forest itself in terms of timber" (Mabberly 1992:263). However, rattan cultivation has not yet been proven to be ecologically sound, and most rattan is still being collected from wild populations. The combination of continued deforestation and the high demand for rattan products has seriously reduced many rattan populations (Johnson 1996).

Economy

Rattans are indispensable to people in South East Asia both as a part of daily life in traditional communities and as an economic resource in commercial markets. The physical properties of rattan allow it to be used for countless purposes: it is light, strong, round, straight and smooth; it can be split lengthwise into strips or fibres; it is very pliable; it has a hard outer layer but can be perforated; and it is free from any noticeable taste or smell (Piper 1992). A few of its many uses include house construction, binding, basketry, hunting snares and fish traps, weapons and musical instruments. Some species are also used for food, medicinal, and ritual purposes (Ave 1988). Underneath the scaly covering of the fruit is a layer of flesh, which is sour and inedible in some species but sweet and tasty in others. The fruits are used for their juices, eaten whole or pickled. Certain species are used in herbal medicines, such as *Calamus ornatus*, used as an anaesthetic in childbirth in the Philippines (Piper 1992). The palm heart or cabbage is eaten as a vegetable, and is also used for medicinal purposes. The palm cabbages of *Calamus exilis*, *Daemonorops grandis*, *Daemonorops verticillaris*, *Korthalsia rigida*, and *Plectomiopsis geminiflora* are all eaten raw to treat coughing and stomach ailments (Ave 1988).

Rattans are also an important source of cash income for both forest-dwelling people and small farmers in South East Asia (Siebert 1991). During the period of Dutch rule in Indonesia, rattans were a more valuable trade item than timber (Hardjono 1991). For generations, rattan has been cultivated on a village scale for domestic use (Dransfield and Manokaran 1993). Rattan production in the rainforests of South Eastern Borneo has been described as "an indigenous system of producing both food and cash crop without ecological disruption" (Weinstock 1985). Land, which would otherwise be left fallow after one to two years of food production, is instead planted with rattan and then harvested after a period of seven to fifteen years. The rattan is used domestically or sold, the remaining vegetation in the garden is then cut and burned, and the garden is again planted with food crops (Weinstock 1985).

Rattans are also very popular in Europe and North America where they are used mainly for wicker furniture and handicrafts. The world-wide popularity of rattans, combined with habitat destruction as a result of deforestation from timber harvesting and conversion of forest to agricultural land, has led to many species of rattan being threatened with extinction (Siebert 1991). By the late 1960s, the demand for rattan had grown to surpass the supply and by as early as the 1980s natural stocks were either threatened with extinction or already depleted (Kartinawata et al. 1983).

Biology and Range

Rattans are climbing palms of the subfamily *Calamoidae*. They form an important component of Old World tropical rain forests. Although relatively little research has been done, it is estimated that there are at least 13 genera and 600 species of rattan (Dransfield and Manokaran 1993). They display an incredibly diverse range of ecological adaptations that allow them to range widely at many different elevations, forest types, and soil conditions. They also display a great deal of morphological variability. Rattan stems can be either single- or multi-stemmed (see Figure 4); climbing, creeping or erect; branching or non-branching; they may have pinnate (leaflets arranged on each side of a central axis, as with a feather) or semi-palmate leaves (shaped like the palm of a hand, with ribs or veins radiating from a single point); inflorescences (the part of a plant which includes all the flowering branches) may be pleoanthic (able to flower more than once) or hapxanthic (die after flowering only once); and plants may be heavily armored with spines or almost bare (Siebert 1991, Stewart 1994).

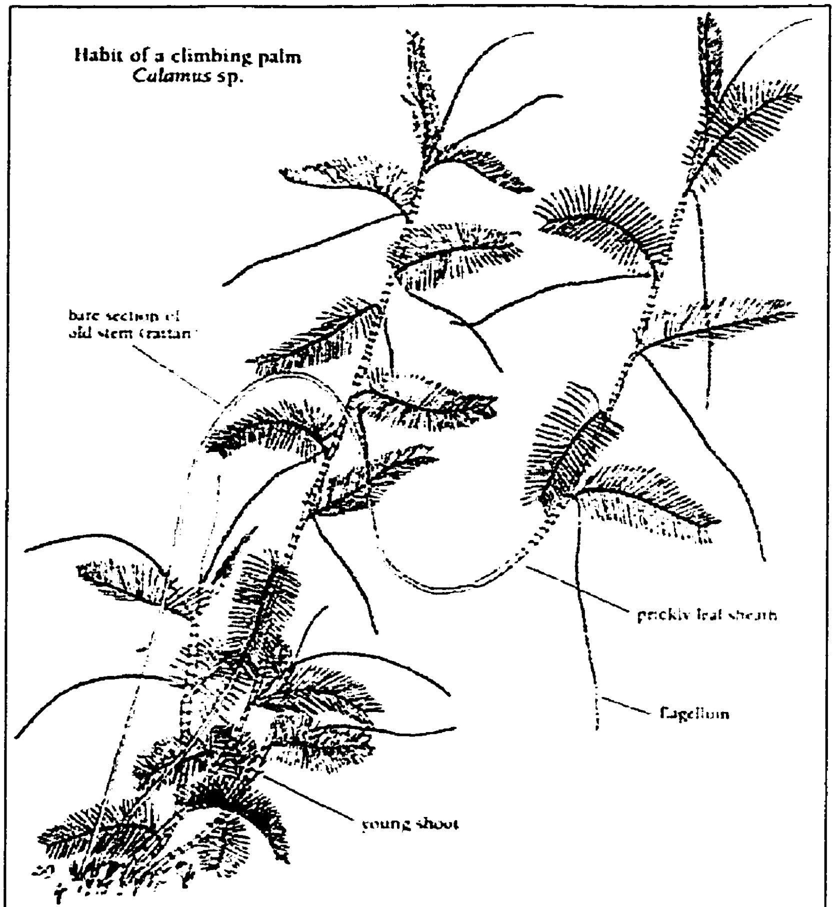


Figure 4. Multi-Stemmed Rattan (Jones 1995:44).

Rattans have an unusual ecological role in that they can exist at all levels of the forest canopy (Tomlinson 1991). They start at ground level as seedlings and then pull themselves up through the canopy leaf by leaf using surrounding plants for support. Certain species of rattan depend on the light from gaps in the canopy, while others prefer shade, and indeed there appears to be a wide enough range of rattans to suit all the different light regimes of the forest (Dransfield and Manokaran 1993).

The multi-stemmed or "clumped" species are able to regenerate from the base after cutting, but the single-stemmed or "solitary" species cannot (Kartinawata et al. 1983). Rattan consists of solid canes that grow only at the tip of the stem from an area known as the palm heart or cabbage. The canes appear to be jointed like bamboo, but the rings along the stem are actually nodes that mark the base of a leaf sheath that once protected the stem (Piper 1992). These spiny leaf sheaths cover the cane or stem and act to both defend the plant and help it climb. Rattans can grow rapidly to amazing lengths. One of the most important commercial species, *Calamus manan*, has been recorded to reach a length of 171 metres (Siebert 1991).

Ranging from the West African coast across to Fiji, rattans reach their greatest abundance and diversity in South East Asia (Siebert 1991). Rattans' incredibly diverse range of ecological adaptations allow them to range widely at many different elevations, forest types and soil conditions. The widespread distribution of rattans, along with their ability to produce great amounts of fruit, suggests that they are an important food source for many species of wildlife. Both arboreal and terrestrial forest dwellers prey on rattan fruit and/or rattan hearts, some of which include orangutans, monkeys, birds, elephants, wild cattle, pigs and squirrels (Siebert 1991). Orangutans in particular rely on rattan in times of food scarcity, consuming up to ten hearts of mature rattans in one day (Russon personal communication). Animals appear to be the main form of seed dispersal, which they accomplish either by eating the fruit whole or sucking and spitting it out (Dransfield and Manokaran 1993). Aside from Rickson and Rickson's (1986) investigations into the relationship between ants and host rattans, almost nothing is known about the overall importance of rattans to the fauna of South East Asia, or about many other aspects of rattan natural history; and this represents important research needs in the field of tropical ecology and wildlife biology (Siebert 1991).

The Rattan Industry

The rattan industry is big business, worth billions of dollars worldwide. A 1985 estimate of international trade was US$4 billion annually, and as of 1997, the international trade was worth approximately US$6.5 billion annually (International Tropical Timber Trade Organization 1997). 0.7 billion of the world's 5 billion people are involved in the trade of rattan and rattan products (Dransfield and Manokaran 1993).

International trade focuses on about 25 species, with those most favoured for furniture making quickly disappearing (Siebert 1991). During the 1970s, Singapore and Hong Kong, neither with harvestable rattan of their own, were making billions of dollars importing raw rattan (90% from Indonesia) and processing it into semi-finished and finished products. In 1977, Singapore earned over US$21 million and Hong Kong earned US$68 million, while Indonesia earned only US$15 million. During the 1980s, Indonesia, Thailand, Malaysia and the Philippines all banned the export of rattan except as finished products in an attempt to promote the growth of rattan-based industries in their own countries and to protect their dwindling wild resources. By the early 1990s, Indonesia was earning about US$600 million annually (Dransfield and Manokaran 1993). While this certainly benefited the Indonesian government, it has led to hardships for small communities dependent on the rattan industry. For example, the ban was intended to increase national profits from rattan by encouraging local processing, but instead it lowered prices to the point that collectors and growers of rattan stopped harvesting. This in turn led to a shortage of supplies for existing factories, which were themselves facing severe quality controls for the finished products. In North Hula Sungai, Indonesia, the production of rattan carpets used to be an important source of village income until new laws gave export licenses to only a few city factories (in order to prevent overproduction for the main Japanese export market). Carpets could only be sold in local markets, and the rural industry was almost wiped out (Brookfield et al. 1995).

In June 1995, Indonesia lifted the ban on the export of raw rattans, replacing it with a heavy export duty, and rattan exports have continued to rise (Brookfield et al. 1995). This huge demand for rattans has had a deleterious effect on wild populations, largely due to the biology of rattans. Many of the most popular commercial species are single-stemmed plants with only one growing point; hence, when the stem is cut, the entire plant dies. Habitat requirements for certain species are quite specific and difficult to replicate in plantations, and so most collecting is still done in the wild despite dwindling populations.

Although traditional systems of harvesting cause little harm to wild rattan populations or the forest, current market forces and practices have thrown those systems out of balance. In Borneo, for example, high rattan prices have led to the commercialization of rattan, thus greatly increasing the amount of rattan being harvested. People collecting rattan are now using destructive and inefficient collecting and marketing practices because it brings them a greater financial profit. They are harvesting immature canes and insufficiently drying the rattan before building or shipping it (DiCastri et al.1983, Peters 1996). There is great pressure to overcut, and even the cultivated rattan gardens are being cut at increasingly shorter intervals with a subsequent decline in both yield and quality of cane (Weinstock 1983).

Current Status

The rattans have been among the least protected groups of flowering plants and many species have become severely threatened or very rare (Dransfield 1981), especially the ones most used for commercial purposes such as the large-diameter *Calamus manan* used in furniture-making (Johnson 1996, Peters 1996). If present rates of exploitation continue, rattan populations will be exhausted in less than a decade. Prices have risen to the point that all stems of rattan are being collected, even those of immature plants and species not previously collected. The most valuable commercial species, such as *Calamus manan*, are single-stemmed and unable to regenerate after cutting, and are thus being seriously depleted (Peters 1996). Collectors take immature plants, leaving fewer mature seed-producing plants to restock the population, thus bringing the species ever closer to extinction (Kartinawata et al.1983). A 1987 study estimated that approximately 35% of the rattan species in Peninsular Malaysia, 25% in Sabah, and 30% in Sarawak were threatened with extinction, and one can safely assume that the situation has only worsened (Siebert 1991). The official status of rattan populations in other important areas such as Sulawesi, Sumatra and Kalimantan is not known.

Conservation Efforts

Botanists have recently been stressing the need to conserve what is left of wild rattan populations. This could be accomplished by: (1) controlling the exploitation of wild populations; (2) identifying and developing alternatives to rattans for use in furniture and handicraft industries; and (3) cultivating rattans in forest preserves (Siebert 1991).

Protecting Wild Populations: The best way to protect the remaining wild populations of rattans would be to protect their habitat. Unfortunately, it is almost impossible to control the collection of wild rattans. Logging roads continue to open up more and more areas to rattan collectors. Even when licenses are issued and royalties paid to forestry departments, harvesting is still carried out unsustainably (Dransfield and Manokaran 1993) because there is no agreement on what a "sustainable" rattan harvest is.

Identifying and Developing Alternatives to Rattan: Substitutes for rattans are already in use. Two examples are Buri palms used for furniture in the Philippines and wood from cultivated surian trees used instead of *Calamus manan* as basket frames in Sumatra (Siebert 1991). Attempts are also being made to substitute more abundant species of rattans for endangered species. However, this approach just shifts the exploitation to different species without addressing the underlying problem of overexploitation.

Cultivating Rattan in Forest Preserves: Sustained yield harvesting of rattans in forest preserves is being promoted by conservationists and economists alike as a method of providing local people with an economic incentive to preserve forest cover while maintaining viable populations of rattan in the wild. Yet given how little is known about rattan ecology, it seems unlikely that an accurate "sustained yield" can be determined at this point in time.

Both smallholder and intensive rattan cultivation have been suggested as a means of protecting wild populations of rattan, yet problems exist with both methods. Small holder cultivation of rattan gardens is successful on a small scale and is preferable to harvesting from wild populations, but as elsewhere in the world, there is a large gap between small local markets and large producers. In spite of the huge profits made in Indonesia from the export of non-timber forest products like rattan, local collectors have continually been displaced in favour of timber production (Hurst 1990). Intensive rattan cultivation is problematic for many reasons, those common to all plantations (i.e. vulnerability to insect infestations) and those specific to rattan, such as the fact that the most popular commercial species are single-stemmed plants that do not resprout after cutting and that they also need a specific habitat that is not easily duplicated in a plantation setting (Dransfield and Manokaran 1993).

None of these proposals for rattan conservation takes into consideration the role of rattans in the lives of other forest species. The forest ecosystem is incredibly complex, making it impossible to focus on one species without recognizing the part it plays within the larger community. It is not simply a case of the human relationship with rattans: if we are to properly study and protect endangered rattan species, we must investigate all of the many other relationships of which rattan species are a part. For the purposes of this study, the relationship to be focused on is that between orangutans and rattans.

CHAPTER FIVE: INVESTIGATION OF THE ECOLOGICAL IMPACT OF REINTRODUCED ORANGUTANS ON RATTAN POPULATIONS

The Problem

As put forward in Chapter One, the orangutan is an endangered species whose survival in the wild now depends upon protecting suitable habitat. A crucial factor in determining suitable habitat is food availability. This study aims to provide information about the relationship between orangutans and one food source, rattans, by gathering data on the role of rattans in orangutan diets (i.e., frequency of rattan consumption, species and parts consumed, growth stage of the plants involved, orangutans' methods for obtaining rattans, type and degree of damage inflicted) and rattan recovery post-damage.

Subjects

The subjects of this study consisted of a community of reintroduced orangutans in the Sungai Wain Forest of East Kalimantan, Indonesia. According to the Balikpapan Orangutan Society, 85 orangutans were officially released into the forest between May 1992 and May 1996 (BOS 1998). During the course of this study, eight orangutans were sighted and six of the eight were tracked as subjects[i]. For the full day focal individual follows, these subjects were two females and four males ranging from six to eleven years of age (see Table 1). It was not possible to devote equal time to each subject because the decision as to who to follow was usually dependent upon who appeared at the provisioning site each morning.

Table 1. Orangutan Subjects

Name	*Sex*	*Year of Birth*	*Release Date*
Charlie	M	1986	30/05/92
Enggong	M	1991	08/02/94
Judi	F	1983	23/05/96
Panjul	M	1987	23/05/96
Paul	M	1990	7/12/94; wounded 17/01/95; re-released 11/03/95
Siti	F	1991	16/05/96

Setting

The study took place in the Sungai Wain Forest of East Kalimantan, Indonesia. At the time of the study, the Sungai Wain Forest was approximately 11,000 hectares in area (Balikpapan Orangutan Society 1998, Peters 1995). A large portion of the forest was lost to fires in March and April of 1998 and it is estimated that less than 4,000 hectares of forest remain (Balikpapan Orangutan Society/USA 1998, Fredriksson personal communication, Russon personal communication). The forest was designated a protected area in order to preserve its function as a water catchment for Balikpapan, a city of 100,000 people located 15 kilometres south of the forest. A lowland dipterocarp primary forest[ii], it is home to a wide variety of wildlife and was chosen as a reintroduction site for ex-captive orangutans by Wanariset's Orangutan Reintroduction Project (Peters 1995, Smits et al 1995)(see Figure 5).

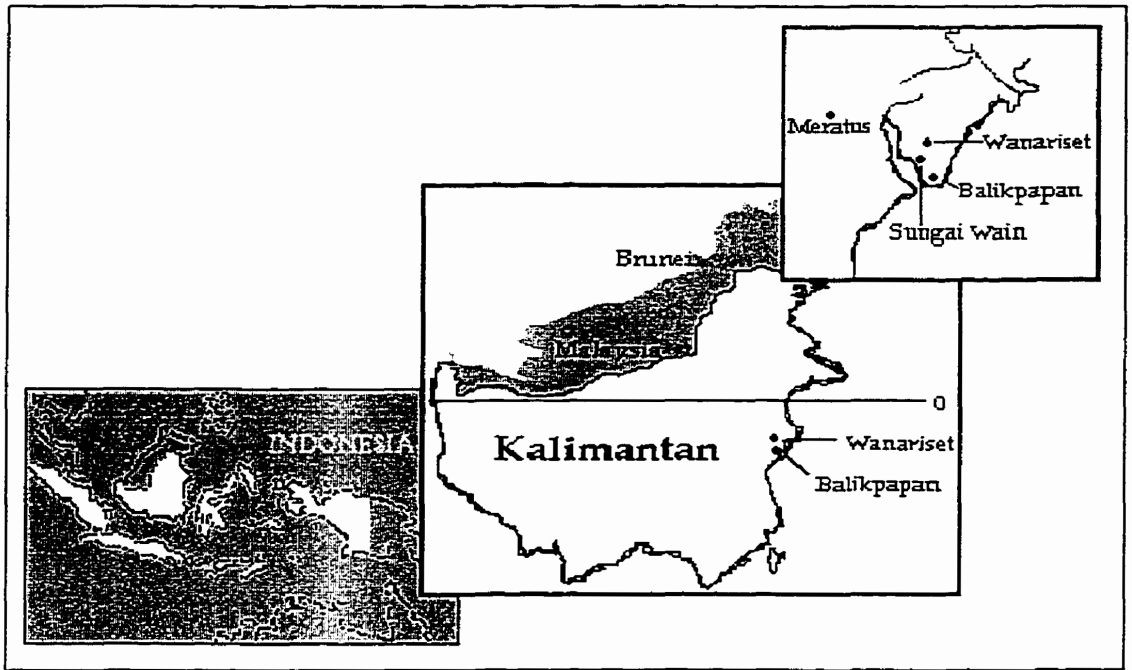


Figure 5. Location of Sungai Wain Forest within East Kalimantan, Indonesia (Balikpapan Orangutan Society Web Page 1998)

The study was conducted for a period of three months, between September and December of 1997, within the several square kilometre study area in the middle of the forest (see Figure 6). During this period, the island of Borneo was suffering from the effects of a prolonged and severe drought, coupled with widespread forest fires. This provided for exceptional conditions and helped to highlight the importance of rattans in the diet of orangutans. Long dry seasons are a characteristic but infrequent component of the local climate; dry conditions are in fact necessary to induce fruiting. The dryness had induced extensive fruiting, but the extremely severe drought put the fruit crop at risk. As the fruit was not yet ready for consumption over the timeframe of this study, the orangutans had to rely on other sources of food. Food supplies were relatively scarce and fresh water was increasingly hard to find as rivers dried up and small pools became stagnant.

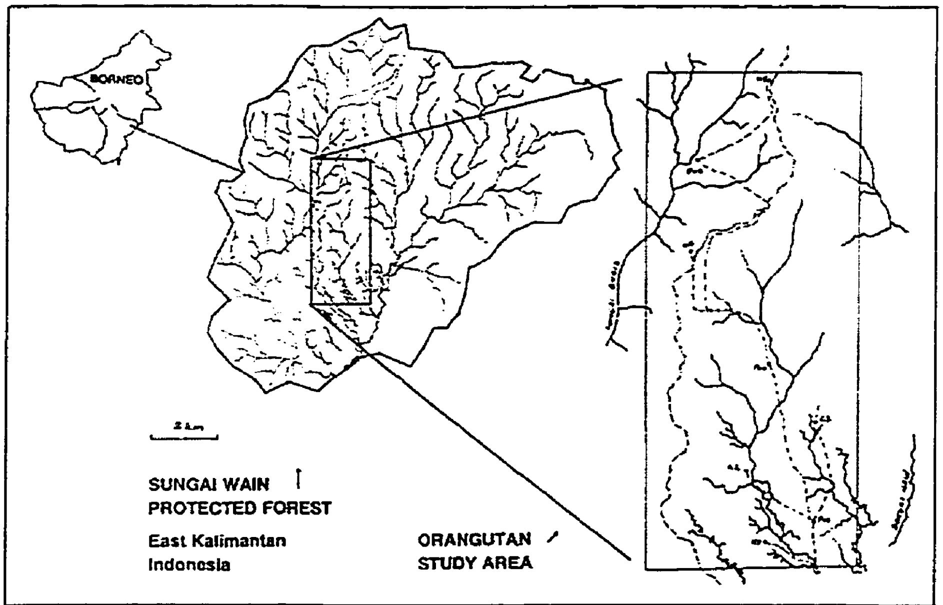


Figure 6. Study Area within Sungai Wain Protected Forest (Map courtesy of Anne Russon)

Materials

The following materials were used in the course of this study: aluminum sheeting, binoculars, camera, compass, field guide to rattan identification, notebooks, permanent marker, spray paint, surveyor's tape, tape measure, wire, and wire cutters.

Procedures

The study procedures can be divided into two sections: one focusing on the establishment and monitoring of botanical plots, and the other focusing on orangutan follows. At the beginning of the study, there were three researchers collecting data:

myself, Dr. A. Russon, and Mas Adriansyah, her research assistant. Dr. Russon has many years of experience studying orangutans in Borneo and she ensured that my observations during the orangutan follows were precise. For the first two months of the study, the three of us worked together; for the last month, I worked with Mas Adriansah. During the follows, Mas Adriansah assisted Dr. Russon in the collection of behavioural data concerning orangutan food processing and, as rattan is one of the foods that orangutans process, I was able to cross-check my field notes against theirs for accuracy. For the first few weeks, Dr. Russon had Mas Adriansyah and me compare daily notes and we soon worked out an efficient system of data collection.

For the establishment of the one trial rattan plot and the first formal rattan plot, all three of us worked together measuring out the plot and labeling and assessing each plant. This served to validate the planned plot size, clarify and standardise the measures, and establish inter-rater agreement on coding. Mas Adriansyah had worked previously in botanical studies and so was very quick to adapt to our system. For the establishment of the second and third plots, Mas Adriansyah and I worked together; he subsequently assisted me in the assessment of the plants each month. Time constraints prevented me from conducting the final assessment of the third plot in December; so, Mas Adriansyah conducted that assessment alone. We had consistently cross-checked data for each plant assessed throughout the study and were in agreement in our coding; therefore, I am confident that Mas Adriansyah's final assessment is reliable.

Rattan Plot Procedures

The plots were selected to compare differing degrees of orangutan predation on rattans and so each of the three plot sites was chosen to represent an area with a different level of orangutan predation (based on our predictions of orangutan presence in those areas). A trial subplot of 10 metre by 10 metres yielded too few rattans and was deemed too small to provide an adequate sample; doubling the size of the subplot provided a sufficient number of rattans while remaining a practical size (in that we could establish and monitor 9 of such subplots over the next 3 months).

The plots were marked out using a compass, a 30-metre measuring tape, spray paint and surveyor's tape. Each plot consisted of three 20 metre by 20 metre subplots arranged at 160 degree angles from a central point. By measuring 14 metres out from a central point, it was possible to avoid including the bare ridge top in the botanical plots. The ridge was not chosen as a prerequisite for plot locations. The first two plot locations happened to be on a ridge, and so the location of the third plot was then chosen to be on a ridge as well so that they would all have similar characteristics. The division into three subplots allowed the creation of a plot that included all sides of the ridge and thus a more balanced sample of the vegetation present. The aim was to estimate the density of rattans in the selected area; the subplots provided three samples from which the majority was taken as being most representative (this method was followed on advice of botanical specialists in Bornean tropical rainforests, Paul Kessler and Ferry Slik, who were studying at the Wanariset-Tropenbos Herbarium). A large tree, for example, had fallen in one of the subplots and as a result there were very few rattans as compared to the other subplots. The elimination of this outlier provided a better approximation for the site.

Plot A was selected to represent an area with frequent orangutan predation. It was the most recent orangutan release site (May 1996) and was thus expected to experience the most frequent orangutan predation. Plot B was selected to represent an area with moderate orangutan predation. It was a release site used several years ago (December 1994) and at the time of the study was known to experience occasional orangutan predation. Release sites are points from which previously captive orangutans from Wanariset's Orangutan Reintroduction Project were released into the forest. Given the nature of orangutans' ranging patterns, release sites are the only sites in the Sungai Wain Forest at which it is possible to establish a priori (then verify) the degree of orangutan presence and, therefore, the likely degree of orangutan damage. Orangutans are solitary animals with large home ranges and an uncanny ability to disappear into their surroundings, making them notoriously difficult to locate (Russon 1996, Sugardjito 1995). The release sites then provide an excellent starting point and the daily monitoring (by Wanariset technicians) of the orangutans around the sites allow researchers to have a good idea of the whereabouts of the orangutans. While Plot C was meant to represent an area with no orangutan predation, several searches throughout the forest failed to reveal an area entirely free from the signs of orangutan presence. Plot C instead represents an area which is not a release site, but which does show signs of occasional orangutan predation.

Plot A and Plot B are located 1.25 km apart along the same low ridge top, and Plot C is located along a low ridge top 1 km north east of Plot A (see Figure 7). Plot A is located at 1 degree 05'26", 116 degrees 49'50"; Plot B is located at 1 degree 06'21", 116 degrees 49'22"; and Plot C is located at 1 degree 4'50", 116 degrees 50'15". Plot C has a naturally occurring open area along the very top of the ridge, while the construction of wooden release cages at Plot A and Plot B also created an open area along that ridge top. The plot sites were then quite uniform in the type of terrain they sampled.

Legend
Shaded area = study area within Sungai Wain Forest (see Figure 6)
____ = river
----- = watershed

Figure 7. Map of Plot Locations within Study Area

Each rattan plant within each subplot was tagged with numbered aluminum labels fastened into place at the base of the stem with a small length of wire. Any debris that was removed from the base of the rattans during this process was then put back into place so as not to alter the light and moisture conditions for the plants. Each plant was assigned a number and then assessed for growth stage, species, number of stems. number of dead stems, and number of orangutan damaged stems. The plots were assessed three times at one-month intervals over the period of the study in order to assess short-term rates of damage and rates of recovery. As far as monitoring the orangutan damage to rattan in the designated plots was concerned, it was not possible to know who caused the rattan damage unless it was directly witnessed; so, the subjects in that portion of the study can be identified only as members of the resident orangutan population.

Rattan Plot Measures

The measures described in Table 2 were used to identify the range of rattan species located in the rattan plots, establish the growth stages and number of stems of the rattans, and establish the form and degree of damage (from orangutan predation) to the rattans.

Table 2. Rattan Plot Measures

Rattan Plot: A rattan plot was a measured area (consisting of 3 sub-plots x 20metres squared) of forest within which all rattans were examined.
Species Identification: South East Asia contains the greatest abundance and diversity of the world's 600 known rattan species, yet many of those species are endemic to particular islands (Dransfield and Manokaran 1993). Many regions have not yet been described but fortunately the setting of this study was included in vanValkenburg's (1997) research. He conducted a thorough survey of the Sungai Wain Forest, one result of which was an

inventory of 30 rattan species. Using this inventory as a starting point, Dr A. Russon compiled a field guide to the rattans of Sungai Wain featuring detailed species descriptions, illustrations and comments. This field guide was used to identify the rattan plants located in plots and encountered when following orangutans. As rattan undergoes great morphological changes during its growth, only older plants (immature or mature) could be positively identified. The species were identified almost exclusively on the basis of sterile material as none of the plants observed were fruiting or flowering during the course of this study. The rattans were assigned final species identifications after the third assessment of the designated plots.

Number of Stems: The number of stems refers to the number of separate stems in each plant and does not include leaves. Rattans can be either single or multi-stemmed, and thus one plant may consist of several units sharing the same root base. New stems of multi-stemmed plants grow from axillary shoots near the base. In this study, the measure "one rattan" consisted of one plant sharing the same root base and often consisted of more than one stem.

Growth Stage: The growth stages of the plants were measured according to Van Valkenburg's system. Van Valkenburg (1997) conducted an extensive study of the rattans in East Kalimantan and developed a system for classifying rattan growth stages. These growth stages are characteristic for rattan as a subfamily and thus consistent across species with only a few exceptions. An individual rattan plant can consist of more than one stem, and thus it is possible for one plant to be in several different growth stages. For the purposes of this study, each stem was assigned a growth stage (see Table 3)

Number of Dead Stems: Dead stems were defined as those that were very dry and brown at the tip. Rattans only have one growing point, the tip of the stem, and so death of this point results in death of the stem.

Number of Orangutan Damaged Stems: Orangutan damage to the plants took several forms and was identified as orangutan damage based on prior behavioural observation by A. Russon[iii] .The first three forms of damage result from the pulling out of new growing shoots from stems at the sucker stage of growth; absent growing shoot; pulled apart base; and cut leaf. The absence of a growing shoot in a rattan sucker is evidence of orangutan damage when there is a neat hole and no sign of a new shoot coming up. A pulled apart base occurs when an orangutan pulls two opposing or opposite leaves apart and to the side in order to open up access to the growing shoot. A cut leaf is the most obvious sign of previous orangutan damage, and it refers to the distinctly cut fan-like pattern of leaf tips that result from an orangutan having pulled out the shoot portion of that leaf. Such damage is unmistakably the work of an orangutan and is very useful in identifying the presence of orangutans in a given area.

Orangutans also cause damage to older rattan plants. The most frequent form of such damage is the consumption of the rattan heart or cabbage. The heart or cabbage is the name given to the growing part of the rattan stem, the apical meristem, located just below the tip of the cane. Orangutans most often access the mature rattan arboreally by means of an overhanging tree or liana, then carefully bite and pull apart the tip of the rattan until the heart is exposed and subsequently consumed. The resultant damage to the stem consists of a missing tip and a shredded stem.

The orangutans in this study were also observed pulling off and eating leaves, pulling off and playing with leaves and/or rattan labels (see Figure 9), and on rare occasions eating the inner core of the leaf petiole of both sucker and mature plants of *Calamus ornatus*. These three forms of damage were not included in the botanical plot observations because predators other than orangutans could also have caused such damage (i.e. squirrels, civets, and monkeys). They were only recorded when directly witnessed, and are thus included in the orangutan follow observations (see Figure 8).

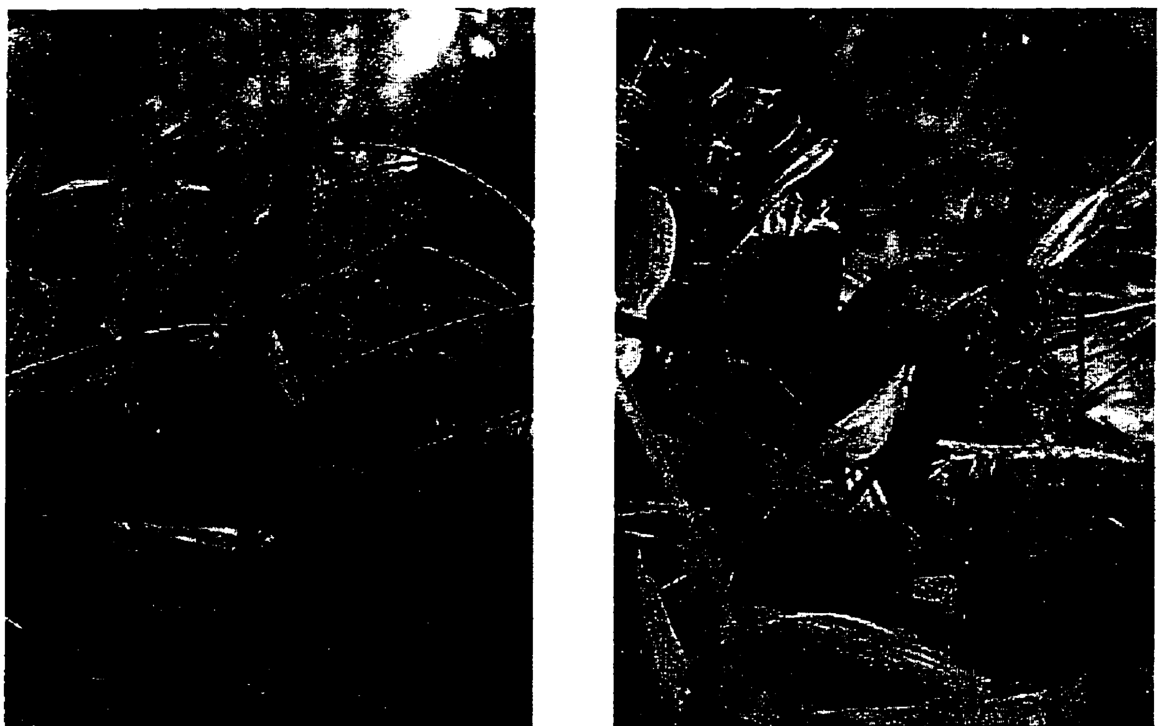


Figure 8. Orangutan Damage to Rattans: Damage to Rattan Heart; "Cut" Leaf. Photos: Anne Russon; Elke Meyfarth

Table 3. Growth Stages of Rattan

Stage	Length of Cane	Appearance of Lower Leaf Sheath
Sucker	0-49cm.	Green
Juvenile	50-199cm.	Green
Immature	>200cm.	Green
Mature	>200cm.	Dead or bare cane exposed

Orangutan Follow Procedures

Full-day focal individual follows were conducted to directly observe orangutan interactions with rattan. For an eight-hour period, usually between 7:30 am and 3:30pm[iv], the orangutans were tracked and observed as they foraged throughout the forest. We usually located the orangutans at one of the provisioning sites (where technicians brought a daily supplement of bananas) and then followed one individual for the remainder of that day. The same orangutan was followed for two to three consecutive days in order to achieve a better approximation of the rate of rattan consumption. Care was taken to keep a respectful distance from the orangutan and to remain a passive observer. For the most part, the orangutans did not seem to mind our presence, but, on the rare occasions when they appeared agitated, we were quick to remove ourselves from the situation.

Orangutan Follow Measures

The measures described in Table 4 were used to identify the range of rattan species consumed by orangutans during the follows, establish the frequency of rattan consumption, establish the growth stages of the rattans, and establish the form and degree of damage (from orangutan predation) to the rattans. The data collected by these measures complement the data collected in the rattan plots and, by following the orangutans on their daily search for food, provides an estimation of the importance of rattans as opposed to other food sources and gives a wider picture of the range of species consumed by orangutans beyond the three plots.

Table 4. Orangutan Follow Measures

	Orangutan Follow: An orangutan "follow" consisted of following and observing a focal individual throughout the course of a day. Follows are the standard method of sampling free-ranging orangutans' behaviour. Among the information recorded was the frequency of rattan consumption; the growth stage of the rattan; the parts of the plant consumed and/or damaged; the methods by which the orangutans consumed rattan; and, when possible, the species of the rattan consumed.
	Frequency of Rattan Consumption: Each incident of rattan consumption and the time it occurred was recorded as a basis for calculating how often the orangutans consumed rattan as opposed to other foods. Records were kept of all foods consumed each day along with the time at which they were consumed.
	***Parts of Rattan Consumed and/or Damaged*:** The part of the plant consumed and/or damaged was recorded. This included the tender white new growth at the base of young shoots, petioles, leaves, and hearts. Orangutans also consume rattan fruit but no rattans were fruiting over the course of this study; for this reason, eating fruit is not included in this catalogue of orangutan damage to rattans.
	Growth Stage of Rattan and Species Identification: The growth stage of the rattan and the species were identified by the methods described above in the Rattan Plot Measures.

Figure 9. Siti Playing with Rattan Label
Photo: Elke Meyfarth

[i] One of the orangutans, Mojo, died at the beginning of this study and so she was not included in the results. Tuti, another female, was observed on several occasions but Charlie, (who seemed quite uncomfortable with our presence), had kidnapped her. To avoid angering Charlie, I stayed away from Tuti and instead concentrated on recording Charlie's behaviour.

[ii] As described by Vandermeer and Perfecto (1995:36-7), " Many forests in Southeast Asia are dominated by a single family of trees, the Dipterocarpaceae. In these forests this family may comprise up to 80% of the canopy trees and 49% of those in the understory.... (this) family contains tree species that typically have straight trunks, grow to a very large size, and can usually be easily converted into valuable timber. Because of their generally large size and uniformly straight trunks, they are a timber company's dream...almost any area of a dipterocarp forest an be utilized for cutting, as compared with the American or African tropics where an area must be carefully scouted ahead of time to locate patches of valuable timber".

[iii] During two years of previous study of foraging in the Sungai Wain orangutans, Dr Russon has witnessed many instances of orangutans consuming rattan and is thus able to identify certain types of damage to rattan as being of definite orangutan origin.

[iv] Orangutans are diurnal; they are typically active between 5:30 am to 6:30 pm. They feed throughout the day, but there is very little feeding in the early morning and late evening (Rodman 1977).

CHAPTER SIX: RESULTS

Introduction

Before presenting the results, it is important to note several factors that may have affected the outcome of this study. As previously mentioned, the study period coincided with a severe drought in East Kalimantan. Food and fresh water were scarce. The lack of other food sources no doubt increased the orangutans' reliance on rattans and, while this may have effected the numbers, it also helped to highlight the importance of rattans as a food source for orangutans.

Several of the orangutans became ill during the course of this study and one appeared to be starving. Two of the illnesses were due to parasites and one was of unknown origins. One orangutan, Mojo, died of the parasite strongoloides at the very beginning of the study. Sick orangutans probably behave differently and likely consume different (or no) foods as compared to healthy orangutans and so those data were not included in the analyses.

The drought also had an effect on the rattan population. Some of the plants were rather dry and, as periods of drought can kill tree saplings, it is likely that the drought also killed some of the younger rattans. A distinction was thus made between rattans that had died as a result of drying out and rattans that had died as a result of orangutan damage. The extreme dryness also probably retarded growth and so the changes observed from month to month within the plots were likely less than they would have been during less severe weather conditions.

As mentioned previously, each plot consisted of three sub-plots; averaging them gave an approximation of rattan presence in the area. When calculating the results, the sub-plot with the lowest number of rattan plants was dropped and the two highest were added together (this method was followed on advice of botanical specialists in Bornean tropical rainforests, Paul Kessler and Ferry Slik, who were studying at the Wanariset-Tropenbos Herbarium). Also, the sampling strategy for the plots was to compare the effects of differing degrees of orangutan predation on rattans, and so the plots were located in areas known to have different degrees of orangutan presence. All three of these sites were on ridge tops and so, as a result, the rattans identified in the plots represent only those rattans that favour hillside habitats. The rattans encountered during the orangutan follows give a slightly better picture of the rattan populations in the larger area because the orangutans ranged well beyond the hilltops.

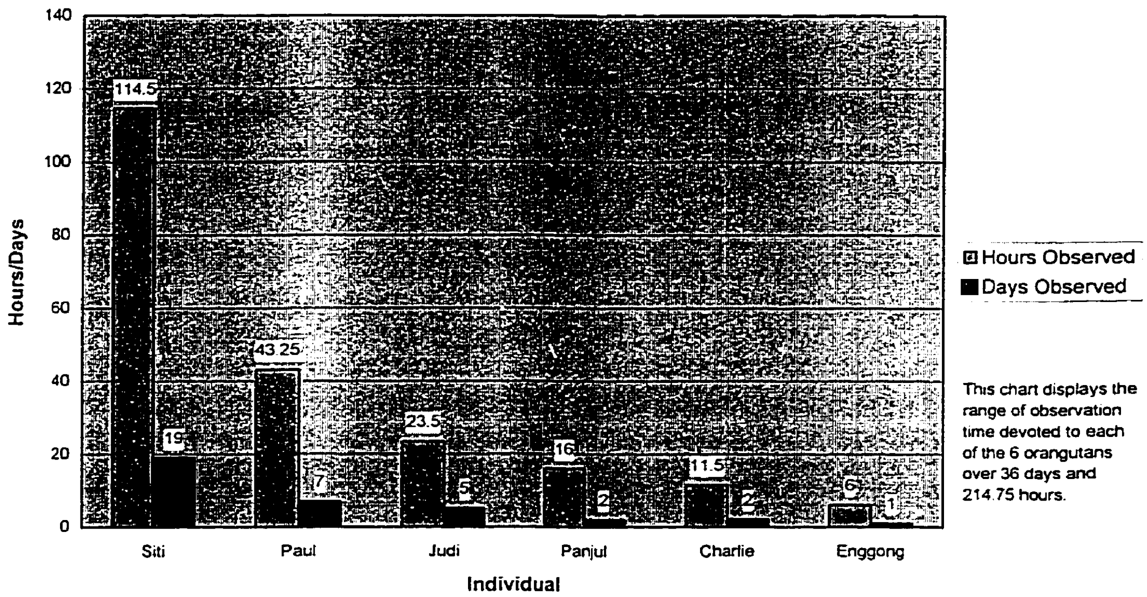
Another factor that has affected the results is the extreme imbalance in sampling with regards to the number of hours spent following each orangutan (see Figure 10). Over half of the total observation time was spent on one individual, Siti, and thus her behaviour and preferences have strongly influenced the overall results. The high frequency of *Plectopmiopsis geminiflora* consumption, for example, is due largely to Siti's apparent preference for that species (see Figure 11). Also, each plot was frequented by different orangutans. Siti and Judi, for example, foraged in the area around Plot A and would not be responsible for any of the rattan damage found around Plots B or C and so personal preferences of the orangutans may have again influenced the results.

Results

Sampling

The orangutan follows generated a total of 214.75 hours of observation over 36 individual days and six orangutans (see Figure 10).

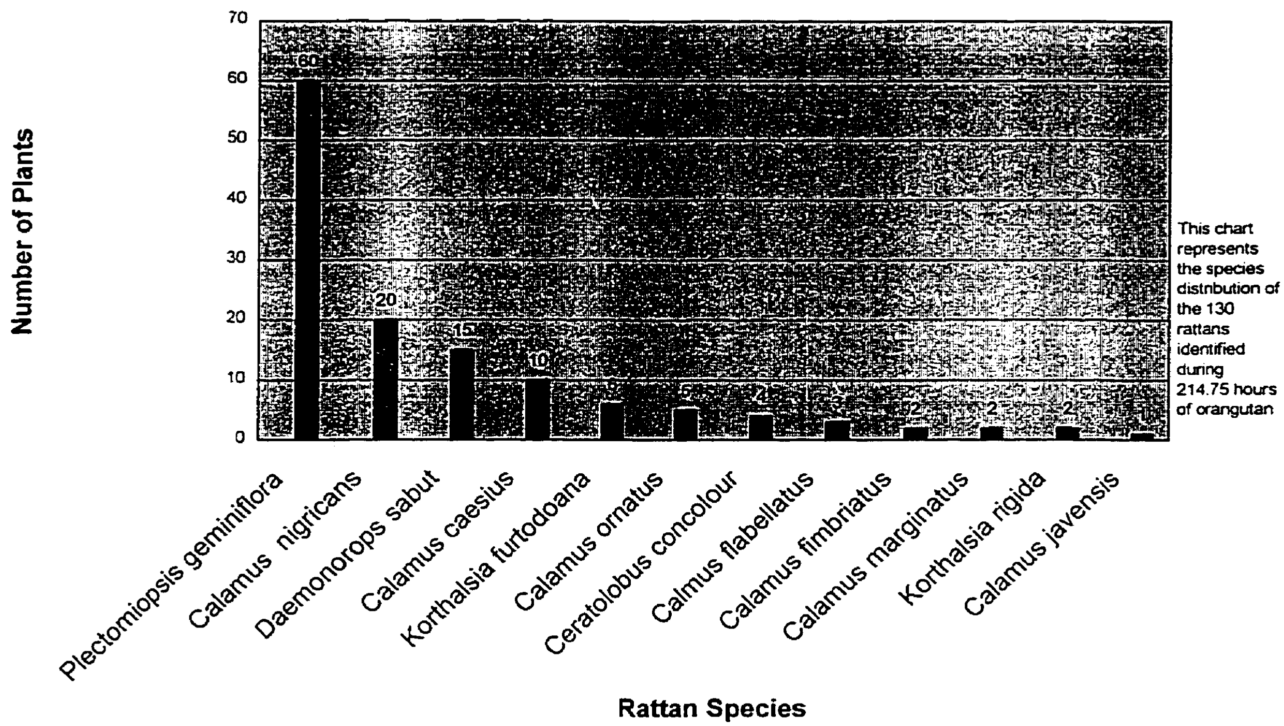
Figure 10. Sampling of Orangutans Observed



Species Identification

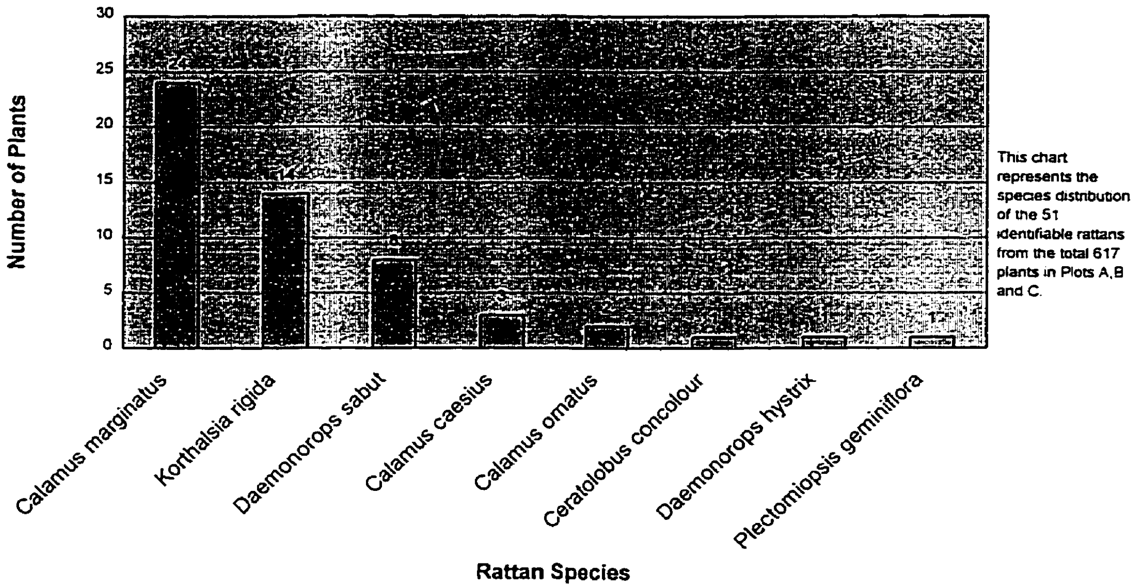
During the course of 214.75 hours of observation, the orangutans were recorded as having interacted with rattan on 400 occasions. Only immature and mature plants or young plants that are part of a larger clump could be positively identified at the species level. The 130 plants that we were able to positively identify represent 12 different species (see Figure 11). All of the species except one, *Calamus marginatus*, are multi-stemmed species.

Figure 11: Rattan Species Consumed During Orangutan Follows



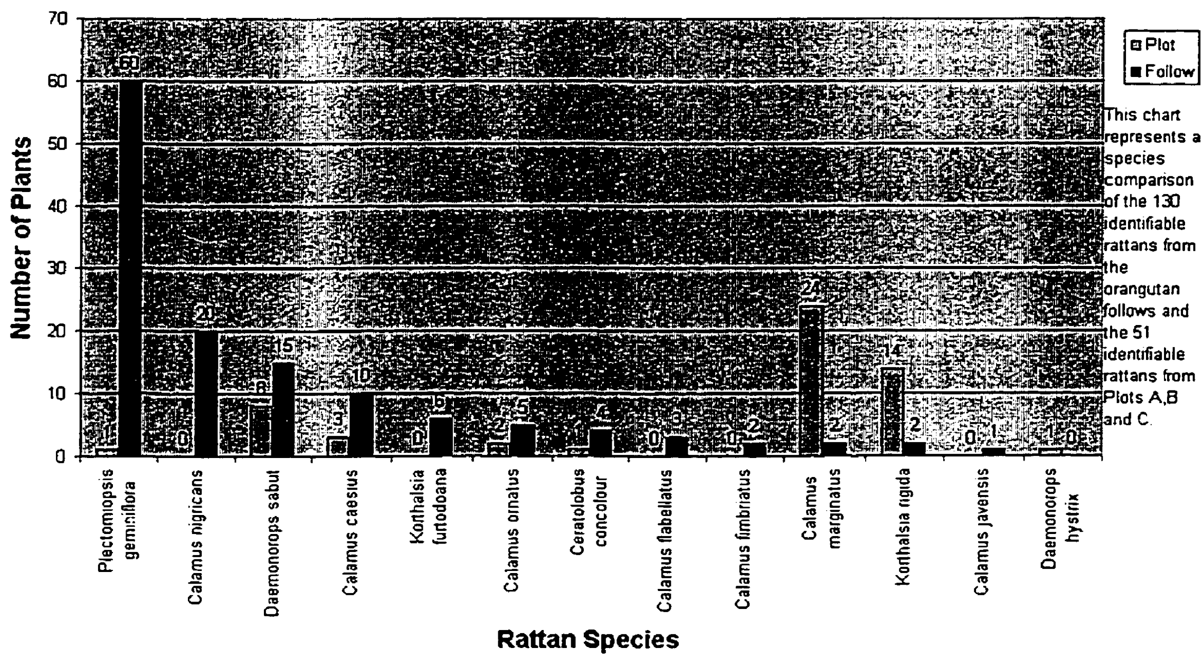
Just 51 of the total 617 plants within Plots A, B, and C could be assigned species classifications. There were eight different species present within the plots (see Figure 12). *Calamus marginatus* was most frequently identified and it dominated Plot B (64%) and Plot C (67%), while Plot A was dominated by *Korthalsia rigida* (59%). The assessment of species domination is limited by the low rate of species identification, but it gives an idea of the different compositions within the plots.

Figure 12: Identifiable Rattans in Plots



Of the 8 species of rattans identified in the plots, 7 showed signs of orangutan damage: This included 15/24 *Calamus marginatus* plants ; 14/14 *Korthalsia rigida* ; 5/8 *Daemonorops sabut* ; 1/3 *Calamus caesius* ; 1/2 *Calamus ornatus* , 1/1 *Daemonorops hystrix* ; 1/1 *Plectomiopsis geminiflora* ; while the one representative of the species Ceratolobus concolour was untouched. When contrasted with the results of Figures 11 and 12, it appears that the orangutans may prefer certain species of rattans more than others (see Figure 13). For example, *C. marginatus* is the dominant species in the plots and 63% of the plants had been damaged by orangutans yet during the follows, *C. marginatus* was the third least frequently chosen of the 12 different species they were observed to consume. Also, *Plectomiopsis geminiflora* was by far the most popular rattan consumed in the follows yet there was only one plant present in the plots, which suggests that the range and distribution of species present in the plots may not parallel orangutan preferences. The location of Plot A was close to the center of Siti's range, and while Plot A did not contain any *P. geminiflora*, Siti was observed to locate and consume *P. geminiflora* on 30 occasions in relatively similar terrain. This suggests that a larger plot sample would be necessary to reliably reflect orangutan patterns of rattan species selection.

Figure 13: Comparison of Rattan Distribution in Plots with Rattan Consumption in Follows

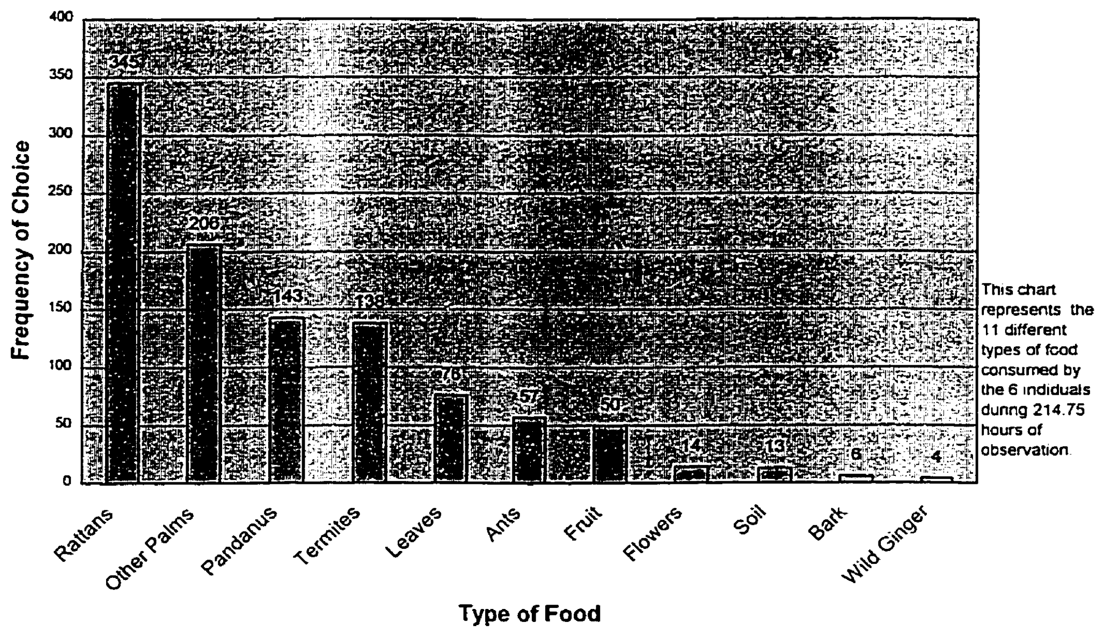


Frequency of Rattan Consumption

Of the 11 different foods consumed by the orangutans during the daily follows, rattan formed the single largest food source in terms of frequency of choice (see Figure

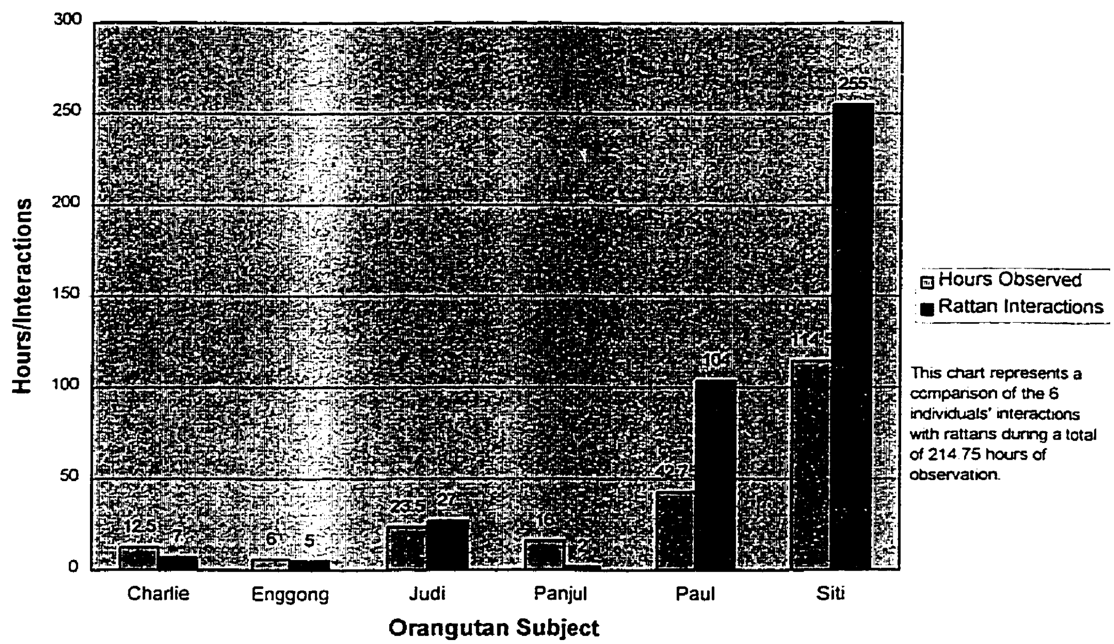
14). This does not reflect physical volume, but rather the number of occasions in which the orangutans chose to consume a particular food item. According to this scoring method, one “rattan” score is equal to one “fruit” score, just as one “other palms” score is equal to one “termites” score. For example, in a given hour, an orangutan might pull and consume a young rattan shoot, sit down for a session of termite consumption, get up and pull another young rattan shoot, and, after eating the shoot, move to a bandang palm and pull and eat a young leaf. The scoring for this would equal two “rattan” (two shoots), one “termites” (one nest), and one “other palms” (one palm leaf). When compared to relative percentages of all other foods, rattan has the highest ranking at 32.8%.

Figure 14. Types of Food Consumed During Orangutan Follows



The average frequency of orangutan-rattan interaction was one interaction every 32.21 minutes (see Figure 15) but varied greatly over individuals (e.g., Siti at one interaction every 26.94 minutes to Panjul at one every 480 minutes). Several of the orangutans were subject to very minimal observation time and thus their results cannot be taken as representative. The frequency of rattan consumption varied not just by individual, but also from day to day. To give an example of this variability. on one 8-hour follow Siti consumed rattan 41 times, while on a later 7.5-hour follow she consumed rattan just 7 times. On one 6.5-hour follow, Paul consumed rattan 29 times while on a 6-hour follow the next month he consumed rattan just 5 times.

Figure 15: Comparison of Individual Interactions with Rattans



Growth Stage of Rattans Consumed

The majority of the rattan plants preyed upon by the orangutans were in the sucker or juvenile stage of growth. In the 400 observed instances of orangutan-rattan interaction, 325 were with suckers or juvenile plants and 68 were with immature or mature plants; failed attempts at rattan consumption accounted for the remaining 7 instances. There were no observations of orangutans consuming seedlings.

The vast majority of rattan plants in the three plots were in the "sucker" stage of growth. Counts changed slightly with each month showing an absolute increase in seedlings in all three plots over the 3 month study period, an absolute increase in suckers for Plots A and C, and a very slight absolute increase in juveniles for Plots B and C (see Figures 16-18). There was no change in the status of immature and mature plants.

Figure 16. Growth Stages of Rattans in Plot A

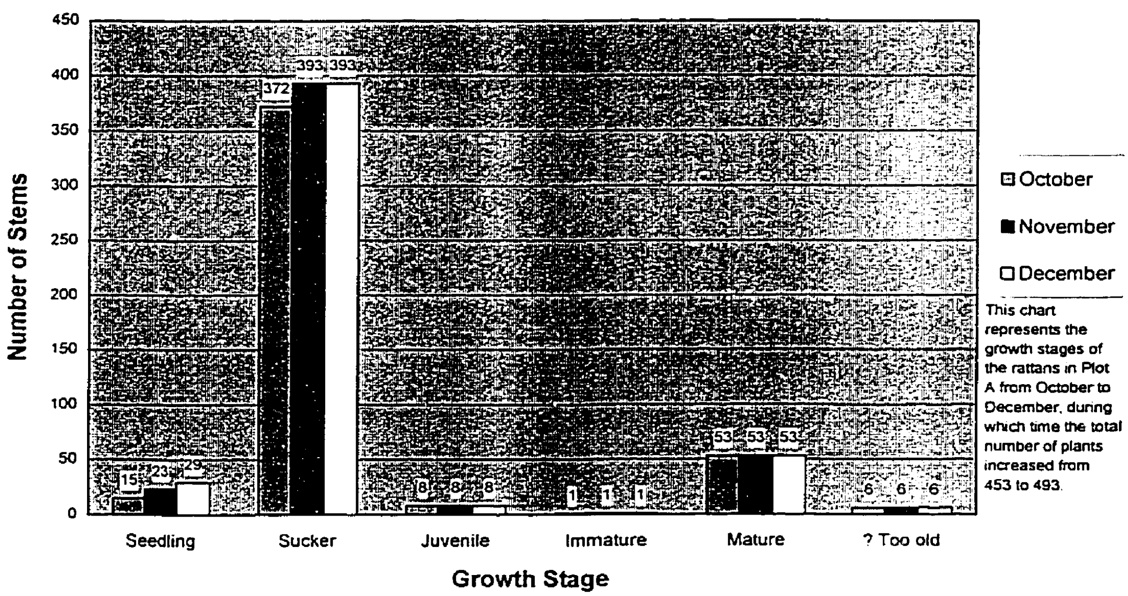


Figure 17. Growth Stages of Rattans in Plot B

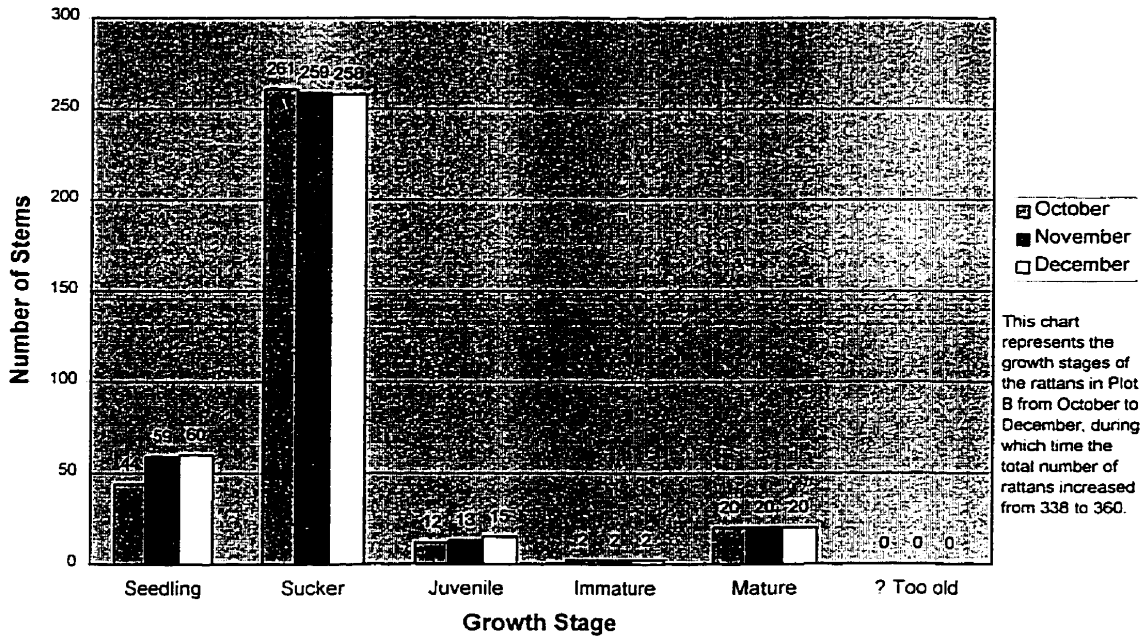
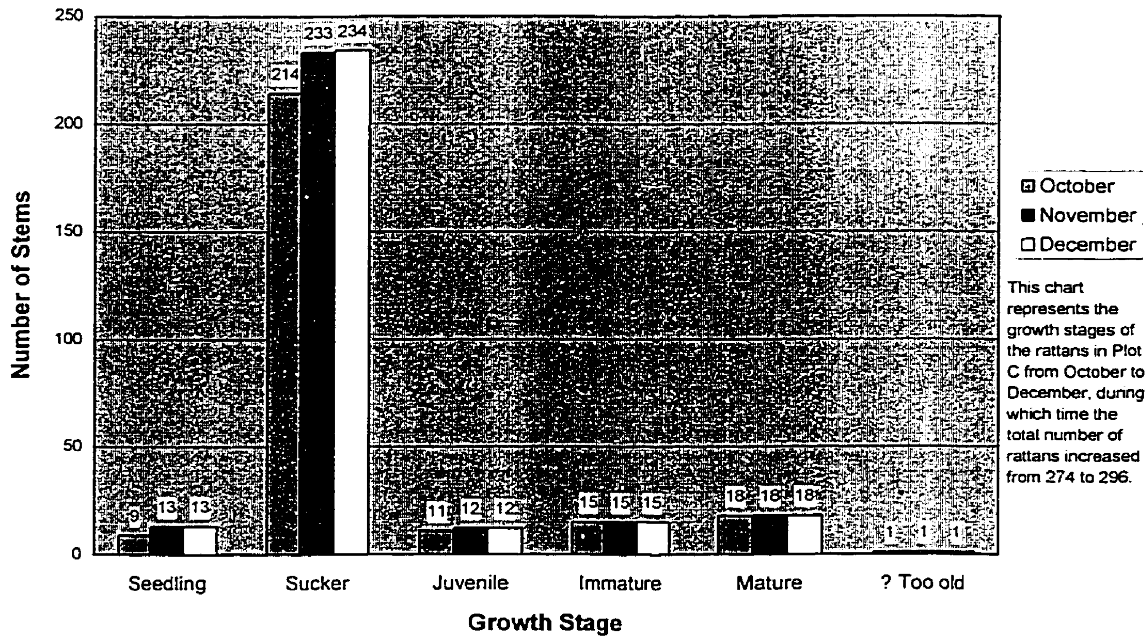


Figure 18. Growth Stages of Rattans in Plot C



Number of Stems

As rattan plants can be either single- or multi-stemmed, the number of stems recorded within the plots is higher than the number of individual plants. All three plots showed an absolute increase in stems over the three-month study period (see Figure 19). The increase in numbers may have been a result of both an increase in the number of young plants and an increase in my ability to spot the plants. It is possible that the difference between the first and second surveys was influenced by my improved ability to locate young plants, but the difference between the second and third surveys likely represents a more accurate difference because of the start of the rains in November. Statistically, the difference across months was not significant as verified by Cochrane's Q (which tests whether matched sets of proportions or frequencies differ significantly among themselves) (see Table 5). Chi-square tables were used to establish critical values for significance tests for Table 5, Table 6 and Table 7, and also to assess the reliability of Cochrane's Q (Cohen and Holliday 1982). The level of significance at which the tests were conducted was 0.05.

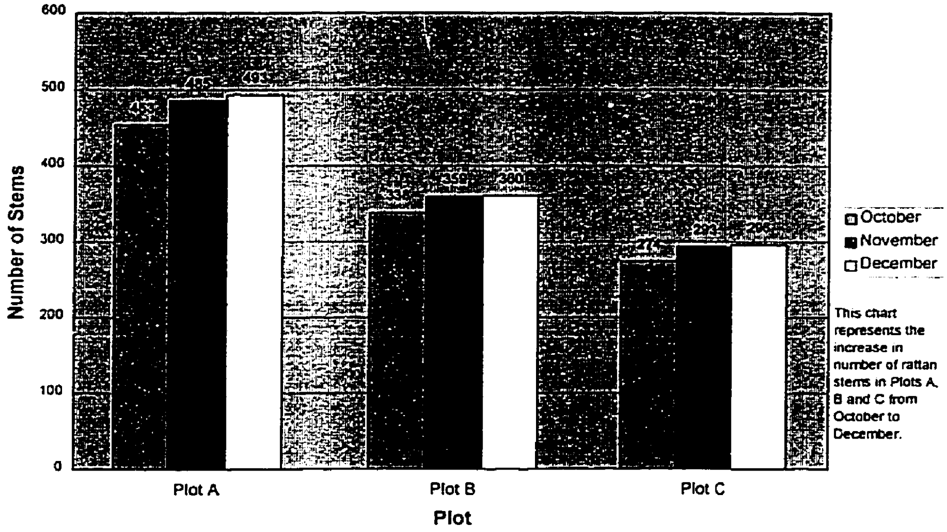
Table 5. Cochrane's Q Test Comparing Changes in Number of Stems in Plots A, B and C from October to December.

Observed Frequencies

	October	November	December
Plot A	454	485	493
Plot B	338	359	293
Plot C	274	293	296

Q = -0.2685 (ns)
df = 3
level of significance = 0.05

Figure 19. Number of Rattan Stems in Plots



Parts of Rattan Consumed and/or Damaged

The part of the rattan consumed was related to the growth stage of the plant. When dealing with suckers, orangutans usually ate the tender white new growth at the base of young shoots; when dealing with more mature plants, they usually ate the heart. Of the 393 observed instances of successful rattan consumption, the vast majority focused on the new growth at the base of young shoots (77% of instances)(see Figure 20). The other three rattan parts consumed were the rattan heart at 16%, rattan leaves at 5%, and the petiole at 2%. The leaves were only observed to be eaten by two of the orangutans, Siti and Judi, and petioles (of one species, *Calamus ornatus*) by one individual, Siti. The latter incident appeared to reflect an orangutan applying a food processing technique common with tree palms.

As most of the rattans in the plots were in the "sucker" stage of growth, it follows that the rattan part most frequently damaged and/or consumed by the orangutans was the growing shoot. This damage took two forms: the absence of a growing shoot, or the presence of "cut" leaves which is a sign of past orangutan damage to a growing shoot. For the older plants, the part damaged and/or consumed by the orangutans was the heart.

Figure 20. Siti Pulling Rattan Shoot from Sucker; Paul Pulling Rattan Shoot from Sucker.
Photos: Elke Meyfarth

Damage Within Plots A, B and C

The rattan plots were chosen to reflect differing degrees of orangutan presence (and therefore probably rattan predation) and a series of chi-square tests were performed to verify whether our initial predictions were correct. The application of a chi-square test to the data of each plot for October, November and December revealed that there was a statistically significant difference between the plots in the extent of rattan damage (see Table 6). In all three chi-square tests, inspection of each cell's contribution to the chi-square identified which cells weighed most heavily in the chi-2 (i.e., deviated most markedly from zero, the expected value). The strongest contributors to the chi-square for October were a higher than expected number of dead stems in Plot A and a higher than expected number of OK stems in Plot C. The chi-squares for November and December both revealed a much lower than expected number of OK stems and a higher than expected number of dead stems in Plot A, and a much higher than expected number of OK stems and lower number of damaged stems in Plot C. These results are consistent with the hypothesis that Plot A, the area with the highest degree of orangutan presence, would have the most signs of orangutan damage to rattans while Plot C, the area with the lowest degree of orangutan presence, would have the least signs of orangutan damage to rattans, and Plot B would fall in the middle.

Table 6. Chi-Square Tests Comparing Extent of Damage Across Plots A, B and C in October, November and December.

Observed Frequencies

October

	Plot A	Plot B	Plot C
OK	156	122	135
Damaged	192	172	105
Dead	106	44	34

Cell Contributions to Chi-Square

2.25	0.61	7.84
0.3	3.65	2.01
9.75	3.53	3.74

chi-square = 33.68; df = 4; p<0.005

November

	Plot A	Plot B	Plot C
OK	114	136	148
Damaged	257	177	104
Dead	113	46	41

Cell Contributions to Chi-Square

18.21	0.83	20.03
3.37	0.29	8.71
9.06	4.68	2.17

chi-square= 67.35; df = 4; p<0.005

December

	Plot A	Plot B	Plot C
OK	105	131	135
Damaged	270	181	114
Dead	118	48	48

Cell Contributions to Chi-Square

18.37	1.9	16.03
3.19	0.1	6.98
7.52	5.38	0.96

chi-square = 60.43; df = 4; p<0.005

Number of Orangutan Damaged Stems

At the time of the first survey in October, 43% of the stems in Plot A were visibly damaged by orangutans, as were 51% in Plot B and 38% in Plot C (see Figures 21-23). The second survey in November found that the percentages had increased to 53% in Plot A, and decreased slightly to 49% in Plot B and 35% in Plot C. The final survey in December found that the percentage of damaged stems in Plot A had increased to 55%, while the percentages in Plots B and C returned to their original 51% and 38% respectively. Overall, this is consistent with the relative rates of orangutan damage we had predicted for the three plots (highest in Plot A, lowest in Plot C). The decrease in percentage of damaged plants in Plots B and C across the three months can be accounted for by an increase in overall plant numbers (new seedlings and suckers) and, in a few cases, the death of a damaged plant (which would then put it in the dead category). The application of Cochrane's Q to test whether proportions of damaged/not damaged/dead stems within each plot changed significantly over the three months did not reveal significant differences (see Table 7). The pattern is not strong enough to reach statistical significance but it is consistent with what we had predicted for the plots and what we had observed during the follows.

Figure 21. Plot A: Progression from October to December

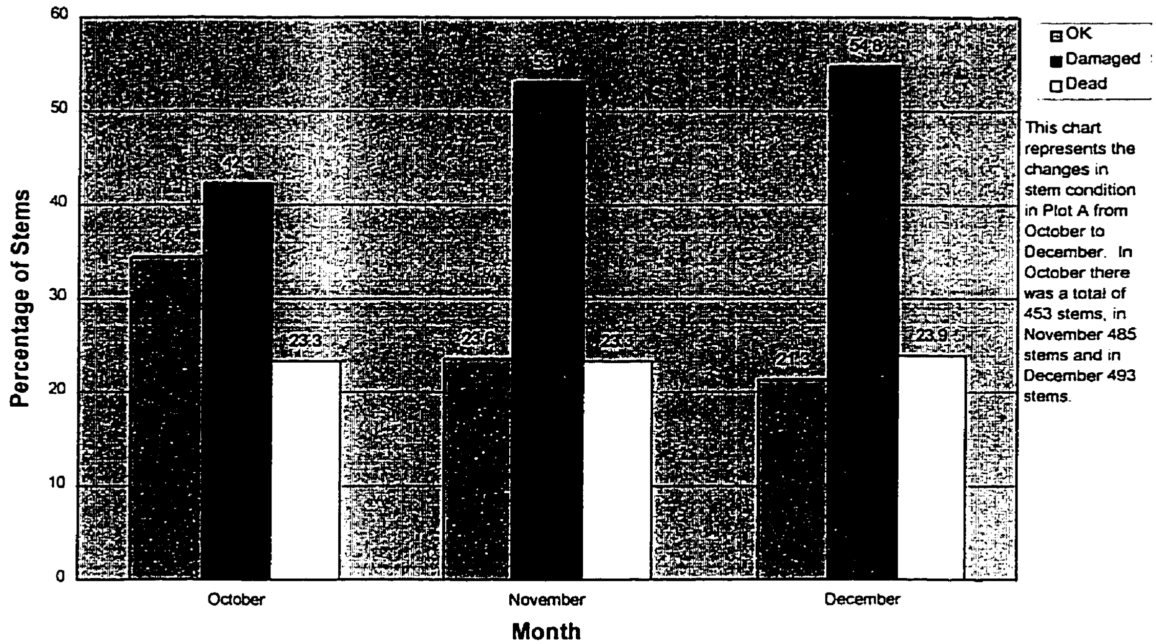


Figure 22. Plot B: Progression from October to December

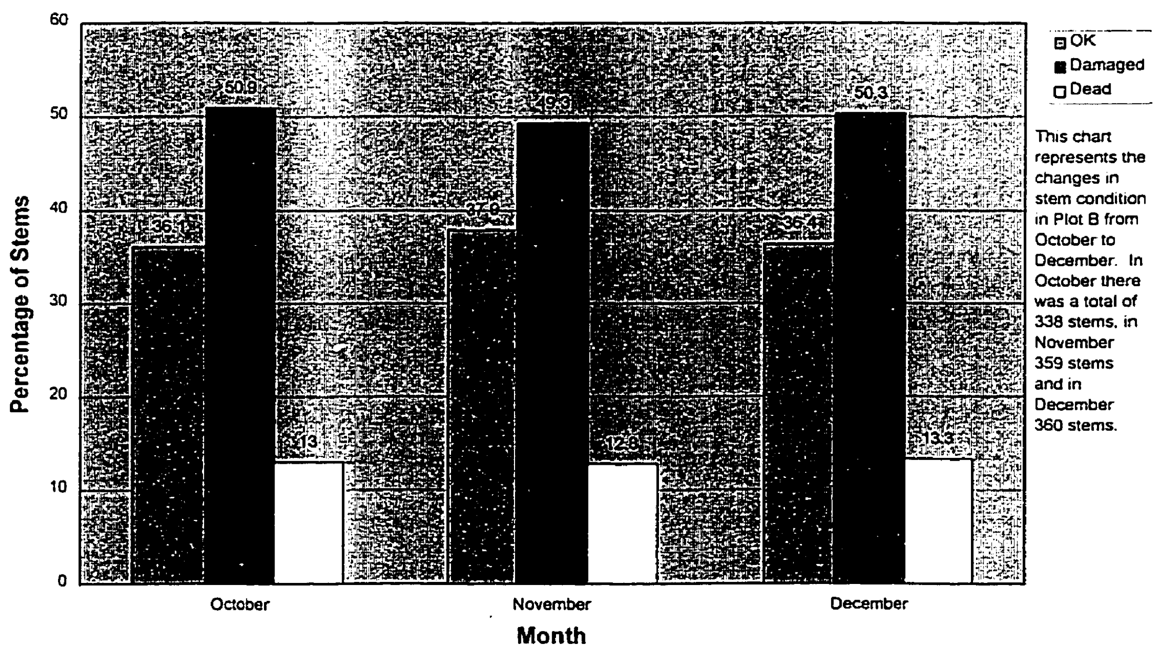


Figure 23. Plot C: Progression from October to November

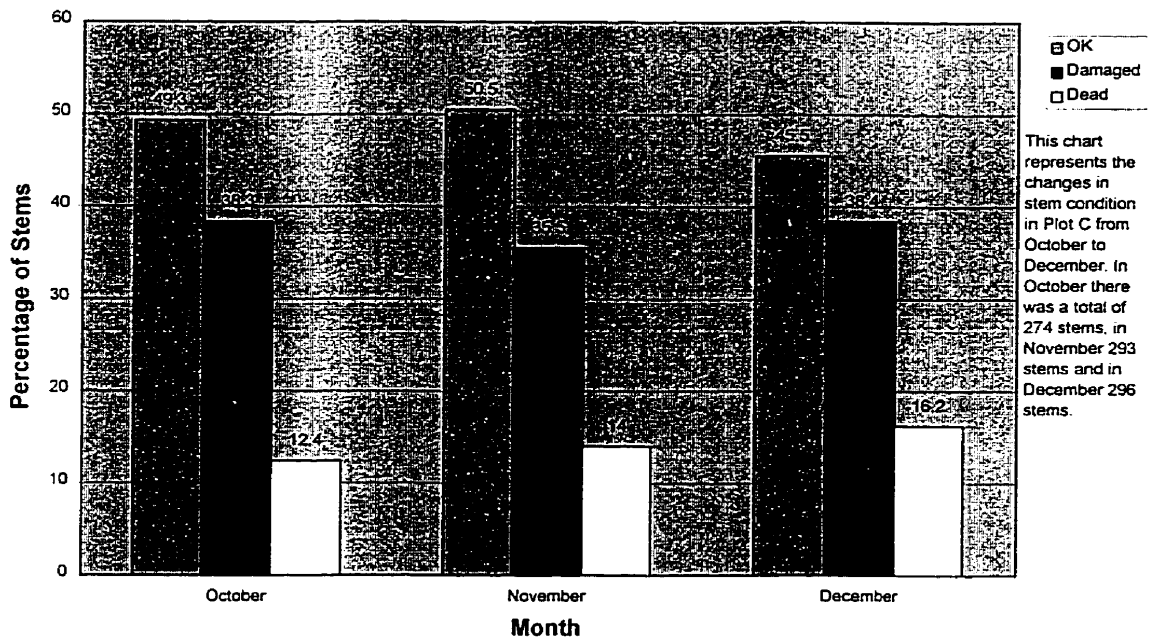


Table 7. Cochrane's Q Test Comparing Changes in Damaged/OK/Dead Stems in Plots A, B and C from October to December

Observed Frequencies

Plot A

	Oct	Nov	Dec
OK	156	114	105
Damaged	192	257	270
Dead	106	113	118

Q = -0.00653 (ns)
df = 3
level of significance = 0.05

Plot B

	Oct	Nov	Dec
OK	122	136	131
Damaged	172	177	181
Dead	44	46	48

Q =- 0.00413 (ns)
df = 3
level of significance = 0.05

Plot C

	Oct	Nov	Dec
OK	135	148	135
Damaged	105	104	114
Dead	34	41	48

Q = -0.00621 (ns)
df = 3
level of significance = 0.05

Number of Dead Stems

At the time of the first survey in October, 23% of the stems in Plot A were recorded as dead, 13% of the stems in Plot B were dead, and 12% of the rattans in Plot C were dead (see Figures 21-23). The second survey in November found that the dead stems in Plot A remained steady at 23%, as did the dead stems in Plot B at 13%, while the percentage of dead stems in Plot C rose slightly to 14%. The final survey in December found a one percent increase of dead stems in Plot A at 24%, while the percentage of dead stems in Plot B remained the same at 13%, and the percentage of dead stems in Plot C had another slight increase to 16%. The Cochrane's Q revealed that these differences over time were not statistically significant but the chi-square tests showed that there were indeed differences in degree of damage between the plots as Plot A had the most signs of orangutan damage and Plot C had the least.

Signs of Rattan Recovery Post-Damage

There were signs of rattan recovery on plants in the "sucker" stage of growth (that had previously been damaged by orangutans) in the form of brand new growing shoots coming up in place of the pulled shoots. There were 101 missing growing shoots pulled out by orangutans in October in Plot A, 94 in Plot B and 50 in Plot C. By November, 5 stems had generated new growing shoots in Plot A, 4 in Plot B and 5 in Plot C (see Figure 24). There were 159 missing growing shoots pulled out by orangutans in November in Plot A, 79 in Plot B and 71 in Plot C. By December, 21 stems had generated new growing shoots in Plot A, 26 in Plot B and 19 in Plot C (see Figure 25).

In total, of the 245 missing growing shoots in orangutan damaged suckers in October, there were 66 new growing shoots by December (see Figure 26). These are clear signs of recovery in a short amount of time. The increase in recovery signs from November to December is most likely linked to that start of the rain after a long period of drought. The three-month time span was too short to assess recovery in the older plants; none of them showed visible signs of recovery from orangutan damage.

During the follows we observed many healthy young rattans with "cut" leaves from past orangutan damage. We also observed several mature rattans that had sustained damage to the heart yet recovered and grown around the damaged area.

Figure 24. Rattan Sucker Recovery October-November

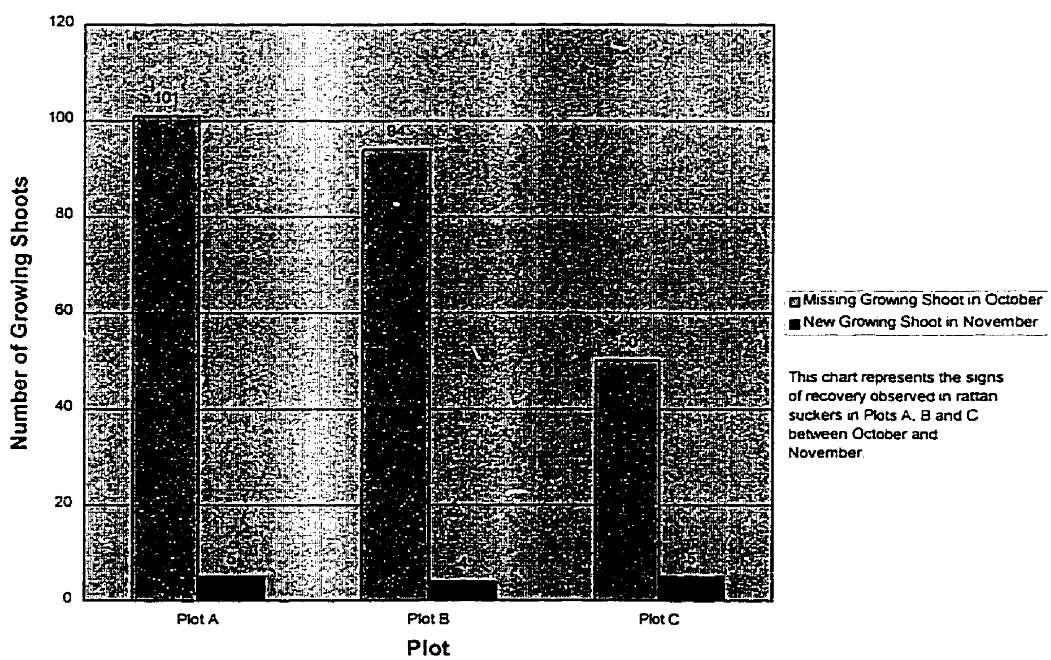


Figure 25. Rattan Sucker Recovery November-December

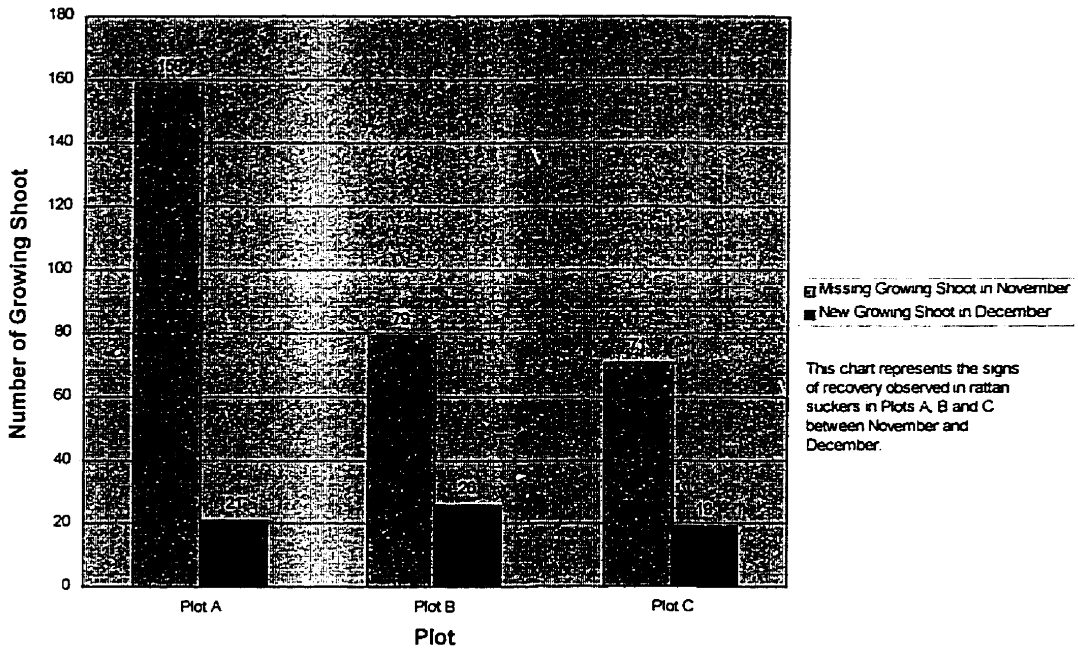
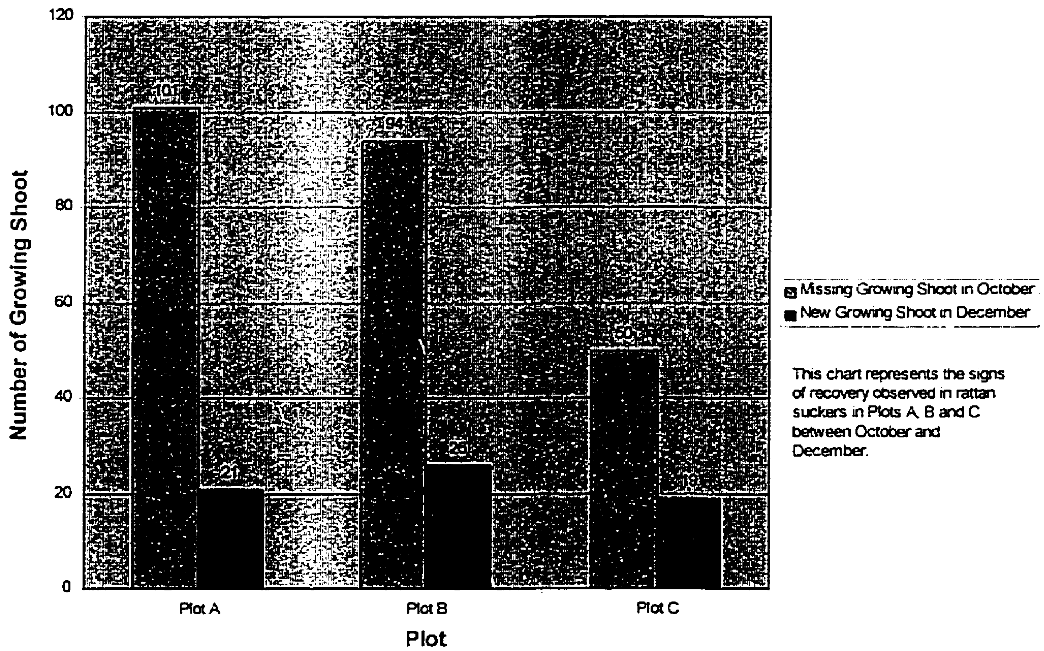


Figure 26. Rattan Sucker Recovery October-December



Orangutan Follow and Rattan Plot Results

The results from the orangutan follows and rattan plots are quite similar. In both the follows and the plots, the vast majority of the rattans targeted by the orangutans were in the "sucker" stage of growth and the goal was the consumption of the tender white base of the growing shoot. When older plants were targeted, the goal was the consumption of the heart. Of the 13 identified species, seven of the eight species identified within the plots were also observed consumed by orangutans during the orangutan follows. Signs of rattan recovery post-orangutan damage were visible both in the plots and during the follows in the form of mature rattans with a new growing tip emerging from the damaged remains of their original stem and also in the widespread presence of "cut" leaves on younger rattan plants.

The major difference between the plot and follow results can be seen in the comparison between rattans consumed most frequently in the follows and rattans consumed most frequently in the plots. There were more rattan species identified in the orangutan follows than in the plots; this was expected as the follows covered a larger area. The most popular rattan species consumed during the follows, however, had only one representative in the plots and the species dominating the plots was not frequently consumed during the follows.

CHAPTER SEVEN: DISCUSSION

Introduction

The results of the study will be discussed as they relate to the three focal issues in this study: the role of rattans in orangutan diets, the impact of orangutans on rattans (rate and degree of damage), and rattan recovery post-damage. Following the discussion of the immediate results and their relevance to orangutan and rattan conservation efforts, there will be a general discussion and critique of said conservation efforts from the perspective of biological conservation.

The Role of Rattans in Orangutan Diets

Rattans were a crucial food source during the three-month span of the study and helped the orangutans survive the drought. Of the foods we observed consumed during the orangutan follows, rattans were consumed most frequently. Indeed, if there had not been adequate rattan available for consumption, it is likely that some of the orangutans would not have survived. Although mentioned as only a minor food item in studies of other orangutan populations (Galdikas 1988, Rodman 1977), rattans appear to be an important food item for the orangutans of Sungai Wain based both on the results of this study and the observations of other researchers in the Sungai Wain Forest (Peters 1995, Russon personal communication). This is in spite of the provisions available daily to the orangutans in Sungai Wain, and it suggests that usage could be even more extensive under strictly feral conditions. As suggested by Peters, this may indicate that orangutan food sources in general are scarce in Sungai Wain Forest.

Rattans can be very difficult foods to process (e.g., rattan hearts), requiring a good deal of time, energy, skill, and strength on the part of the orangutan. According to a study conducted by Fredriksson and Peters to evaluate the success of the Wanariset Orangutan Reintroduction Project, only the experienced orangutans were able to consume the most difficult foods. such as the heart of mature rattans, while the newly-released orangutans were only able to access easier foods, such as insects and leaves. In Peters' comparison of four newly released individuals, it took between three weeks and two months of imitation and trial-by-error learning to acquire the technique for obtaining young rattan shoots, and two to four months before the individuals were observed to consume the heart of mature rattans (Peters 1995). In this study, we observed that the young shoots were the most frequently eaten rattan part; they are among the easiest foods to eat.

The individuals observed in this study exhibited a great deal of skill and determination in their attempts to consume mature rattan hearts and certain individuals were more successful than others were. Factors that appeared to contribute to differences in success rates include greater experience, age, and strength (Peters 1995, personal observation). The time and effort involved in rattan consumption again suggests that rattans are an important food source for orangutans, as they must contain something of enough nutritional value to warrant such an expenditure of energy.

Although the number of damaged rattans was greatest in the area with the most frequent orangutan predation, the damage did not appear to have a significantly negative impact on the rattans. In fact, the orangutan predation may have been stimulating rattan growth because the area with the most orangutan predation also had the highest number of young rattans. However, during my study there were never more than three orangutans in that area at one time and the presence of more orangutans might cause enough pressure to negatively affect the local rattan population. Also this result might have been different if there had been more "preferred" rattan species, such as *Plectomiopsis geminiflora*, within the plots. As it is, the plots were dominated by species for which the orangutans showed less preference (*C. marginatus*, *K. rigida*); the plots were then not entirely representative of the range of rattans sought out and consumed by orangutans. The exact number of orangutans living in the Sungai Wain Protected Forest is not known (during three months in the forest I witnessed only eight individuals) so, at this time, it is not possible to estimate how their future foraging will affect rattans in the forest. On the other hand, it is very likely that a decline in the rattan population would have a seriously negative effect on the orangutans.

Despite the "protected" status of the Sungai Wain Forest, both hunting and resource extraction continue within its boundaries. A recent survey of the perimeter revealed a number of well-worn trails leading into the forest and frequent encounters with people entering the forest to hunt and exiting the forest with timber (Fredriksson personal communication). People in the area regularly enter the forest to collect wood, rattans, palm leaves, animals, birds, fish, and snakes (Drewry 1996). Humans and orangutans are then in direct competition for rattans. It is likely that this competition has become more serious as of late due to the devastating fires in the forest and the increasing poverty of the local people (the economic crash of 1997-98 has taken a huge toll on the Indonesian people).

The orangutans of Sungai Wain eat a variety of rattan species and one of those species is in high demand for human use. *Calamus caesius* is one of the most commercially valuable species in the international rattan trade (Stewart 1994). Of the 12-15 rattan species used most regularly in Borneo in the 1980s, *C. caesius* was the most in demand and the most often planted (Weinstock 1983). It is used for weaving into baskets and mats and also used in the furniture industry (Weinstock 1983). For the past century, *C. caesius* has been grown in large areas of secondary forest along the Barito River in central Kalimantan to supply villagers' rattan needs; *C. caesius* has also been planted in large commercial plantations, such as in a 4,000 hectare plantation in Sabah (Caldecott 1988). That orangutans also consume this valuable rattan species may represent an area of potential conflict as both humans and orangutans are competing for the same species of rattan. *C. caesius* is not a major species sought the orangutans of this study in Sungai Wain but the situation might be different elsewhere. Another of the species eaten by the Sungai Wain orangutans that is also in human demand is *Plectomiopsis geminiflora*, used by local humans to treat stomach ailments and prevent malaria, and orangutans can consume this rattan in great quantities (personal observation).

Impact of Orangutans on Rattans: Rate and Degree of Damage

The three-month study period coincided with a serious drought that had the effect of slowing rattan growth and recovery rates. As such, the changes between months were not great enough to achieve statistical significance. The drought did, however, serve to increase the importance of rattans in the orangutans' diet by limiting other food sources and therefore likely increased the rate at which rattans were damaged by orangutans.

Rate and Degree of Damage

The degree of damage within the plots did follow our predictions (Plot A with the most damage and Plot C with the least) and a series of chi-square tests confirmed that Plot A had a much higher than expected number of dead stems and lower than expected number of OK stems while Plot C had a much higher than expected number of OK stems. All three plots showed an absolute increase in the number of damaged rattans across the three months, and while the change was not statistically significant, Plot A had the greatest absolute increase in the percentage of damaged stems and Plot C had the lowest. While the orangutans did cause damage to many rattans with their food processing methods, in most instances the damage was not fatal. This is supported by the relatively low percentage of dead rattans in the plots. There was, however, a noticeably higher absolute percentage of dead stems in plot A (fully 10% over plot C), which one would expect to have occurred because of higher orangutan predation. The chi-square test revealed that the difference was statistically significant and so the data do suggest that orangutans can kill a substantial proportion of stems under conditions of heavy repeated predation. Death to the plant seemed to occur when the entire base of the plant had been pulled apart; perhaps by repeated or overly vigorous attempts to remove growing shoots. Death also occurred in mature stems when orangutans extracted the rattan heart. As all of the rattan species observed in this study except one were multi-stemmed species, the damage to the heart resulted in death of that particular stem, but not of the plant itself.

While it was to be expected that the area with the most frequent orangutan presence would also be the area with the most orangutan-damaged rattans, it was interesting to discover that Plot A, the area with the most orangutan predation and thus the most damaged rattans, was also the area with highest percentage of rattan suckers. The proportions for the other growth stages are all very similar between the three plots and all three plots showed a similar increase in the total number of rattan stems over the three-month period, so it does not appear that the difference in the number of suckers can be attributed to Plot A's having better overall growing conditions. One possibility is that the orangutan predation may in some way be stimulating the growth of rattan, either through seed dispersal, fertilisation (by faeces), or altering the light conditions. A more thorough and lengthy study would be necessary to assess these possibilities, but the results of this study do offer some indication that orangutan predation may influence rattan growth.

Rattan Recovery Post-Damage

Due to the drought, the three-month study period did not prove to be enough time to provide conclusive answers about rattan recovery rates post-damage. A three-month study during less severe weather conditions would likely have been more successful in detecting recovery (as shown by the increase in rattan recovery rates following the start of the rains at the end of November). However, even during the relatively short three-month time frame of this study, 27% of the suckers that had been missing a growing shoot due to orangutan predation were observed to generate a new growing shoot. The vast majority of orangutan damage was found on young plants in the "sucker" stage of growth. It appears that these young plants are able to recover from the most common type of orangutan damage, i.e., the pulling out of a growing shoot to eat the tender white new growth at its base. The low percentage of dead as compared to damaged plants also seems to support the possibility of rattan recovery.

Damage inflicted on older rattan plants was decidedly more serious because damage to the heart of a mature single-stemmed rattan can lead to death of the stem or, in single-stemmed species, of the entire plant. However, all but one of the rattan species identified during the follows and in the plots are multi-stemmed species. Accordingly, orangutan damage to the heart of a particular stem might lead to the death of that stem but not to the plant as a whole. There were also several instances where the rattan survived the damage to the heart and a new growing tip emerged from the damaged heart and grew out and around the damaged section. While the plant survived, the damage created a crook in the stem that may decrease the rattan's value and usefulness to humans.

Possible Medicinal Benefits of Rattan

Of the rattan species observed to be consumed by the orangutans, three are also consumed by humans for medicinal purposes: *Plectomiopsis geminiflora, Korthalsia rigida*, and *Calamus ornatus*. *Plectomiopsis geminiflora*, known locally as *riwa*, is harvested by humans in the Sungai Wain area. On questioning, local people reported that *P. geminiflora* is eaten to protect against malaria. As in other South East Asian communities, this species is also used to treat coughs and stomach ailments (Ave 1988). During the orangutan follows, *P. geminiflora* was consumed more frequently than any other rattan species, although it was only two orangutans (Judi and Siti) who were responsible for most of this predation. The appeal of this particular species to orangutans may lie partly in the fact that it is a clumping species which produces a large number of stems (some of the clumps observed during the orangutan follows had over 30 stems) and thus multiple stems can be consumed with relative ease at one "sitting;" the stem is also relatively easy to tear open. We found no behavioural indications that consumption was related to ailments: orangutans ate from this rattan on a regular basis and in no instances were visibly ill orangutans observed eating *P. geminiflora*.

The *P. geminiflora* clumps witnessed during the follows had all been repeatedly worked over by orangutans and, given that orangutans seem to have a mental map (MacKinnon 1974) of food locations and availability, it is likely that the clumps are subject to repeat visits by the same individuals. During the orangutan follows, we observed some individuals travelling along the same route that we had observed them use several weeks earlier. Whatever the reason for *P. geminiflora*'s popularity with the orangutans of Sungai Wain, it is likely that they are receiving the same medicinal benefits that humans gain from its consumption.

The orangutans were also observed consuming *Korthalsia rigida*, another rattan species commonly eaten by humans to treat coughs and stomach ailments, and *Calamus ornatus*, a species used as an anaesthetic (Ave 1988). Given that orangutans are so genetically close to humans it is, again, more than likely that they are receiving medicinal benefits from consuming these rattan species. It would be very interesting to test this theory by conducting nutritional and pharmacological analyses of the rattan species consumed by orangutans in order to identify those species with medicinal properties. Such a study could also reveal which rattan species are most valuable to orangutans and, thus, most important to have present in potential orangutan reintroduction or conservation sites.

Surveys assessing forests as potential orangutan habitat have tended to focus on the presence of fruit species and have paid little attention to permanent food species. Permanent foods are those available to the orangutans year-round as opposed to seasonal foods such as fruit. Clearly, permanent foods like rattans play a critical role in survival across particularly stressful times; surveys should assess the availability of permanent foods as well.

Relevance to Orangutan Conservation Efforts

The results of this study highlight the importance of food availability to the success of orangutan reintroduction projects and emphasise the importance of conducting a thorough assessment of potential sites for orangutan reintroduction for their food production capabilities. This is especially important as reintroduction regulations require that the orangutans be released into an area without a resident wild population of orangutans. The absence of a resident population could mean that orangutans are locally extinct or it could mean that there was never a resident orangutan population because the area is unsuitable for orangutan habitation. The effects on reintroduced orangutans may range from malnourishment from inadequate food sources to possible starvation from lack of food. Orangutans, as large bodied animals with a primarily frugivorous diet, have the largest home ranges of the great apes because seasonal variations influence food availability (Parker and Russon 1996, Rodman 1977). If an area lacks adequate permanent food items to sustain the orangutans during periods of fruit scarcity, the orangutans may be forced to leave that area in search of food and, thus, the orangutans may exit the protected release area. Once outside the protected area, the orangutans are vulnerable to hunting and being killed by humans defending their own fruit crops (personal observation). There is one recorded incident of an ex-captive orangutan from Sungai Wain Forest dying after consuming a deliberately poisoned snake fruit (Russon personal communication).

The forest areas most likely to be granted protection status are those least desirable to humans and as humans and orangutans prefer the same type of habitat, it is likely that most areas given over for orangutan reintroduction are not ideal orangutan habitat. The original impetus behind protecting the Sungai Wain Forest lay not in its suitability for orangutans, but rather in its importance as a major water catchment for the

Balikpapan area and its industries, and the Ministry of Forestry recognises that the forest is of high socio-economic value (Drewry 1996). It has been argued that the assessment of the Sungai Wain Forest's carrying capacity for orangutans was based on insufficient data as it was conducted during only one season, no qualitative or quantitative measures were taken of available fruits or flowers, and no list of food species was compiled (Peters 1995). Clearly it is impossible to predict how many, or even if, orangutans can survive in a given area without first conducting a thorough study of the forest itself. To ensure that future sites for orangutan reintroduction meet the needs of their intended population, it is vital that a proper assessment of the area's potential orangutan food sources be conducted before the release of any orangutans and that assessments include consideration of permanent food sources.

Relevance of Results to Rattan Conservation and Sustainable Development Efforts

Rattan studies, both of rattan conservation and the "sustainable" development of rattans, have thus far neglected (with the exception of Rickson and Rickson's (1986) study of rattan-ant relationships) to look at the relationship of rattans with species other then insect pests in plantations (Steiner and Mohammad 1997). The results of this study show a definite relationship between rattans and orangutans, as rattans were shown to be an important food source for the orangutans and the orangutan predation appears to have had an impact on the rattan population. The orangutans clearly damaged the rattans but the results for the degree of damage and rate of recovery were inconclusive, in large part because the drought slowed growth and recovery rates. I do not have data on rattan consumption from non-drought seasons on which to base a formal comparison, but it seems very likely that consumption was intensified during the course of my study because of other food scarcities. This study thus highlights the importance of including other species in studies of rattans in order to gain knowledge of rattan's broader role within the forest ecosystem. Perhaps this study will serve to broaden the perspective of "sustainable" development enthusiasts who currently view rattans only in terms of their relationship with human needs.

"Sustainable" development groups have been quick to adopt rattan as a means of improving local economies by encouraging rattan harvesting and processing. They claim that these projects will cause little harm to the forest, citing studies of traditional swiddens or rattan gardens that show that small scale harvesting of rattan causes little ecological disruption (Godoy and Feaw 1989). However, along with a lack of studies into rattan relationships with other species, the "sustainable" harvest level of rattan[i] is also unknown. The exploitation of rattan is being encouraged without knowing the effects it will have on the rattans, the forest community, and ultimately the forest itself.

The Failure of Orangutan and Rattan Conservation Efforts

Introduction

Conservation efforts for orangutans and rattans have thus far been ineffective and unsuccessful. The numbers of both orangutan and rattan populations continue to decline despite increased awareness of their endangered status. The greatest threats to both orangutans and rattans are deforestation and overexploitation, yet these threats are not properly dealt with by conservation efforts. The idea of fencing off an area to protect it from humans has become largely unpopular. Ecotourism, sustainable development, integrated use: these concepts allow humans to "protect" Nature without denying themselves the continued benefits of using it. What these "conservation" methods fail to appreciate is that wildlife and botanical conservation is really about human management; there would be no need for conservation if there were no humans (Livingston 1981). As described by Wilkinson (1998:19), the study of a particular species for its protection is "essentially an investigation into *human* ecology and behaviour". The above conservation efforts are doomed to fail because they put their faith in a rather naïve view of humanity, believing that humans will act in their species' best interests rather than in their personal ones and thereby adopt "sustainable" patterns of behaviour. Rijksen (1995:18) calls it a "dangerous illusion to believe that an ever-growing swell of people, with ever-expanding desires for material wealth, can live in harmony with nature or for that matter, use natural resources wisely". In his assessment, conservation areas and endangered species must be protected (with law enforcement) and not exploited in any way, for when a policy of sustainable land use is applied to conservation areas, it is "no less than an euphemism for legalising encroachment" (Rijksen 1995:18).

Another major stumbling block to successful protection of endangered species is the recent attempt to "legitimise" the field of wildlife (and botanical) conservation by placing a strong emphasis on numbers (Rijksen 1995). As useful as numbers may be to illustrate a species' endangered status, numbers can also be used as an excuse not to take action. There are still many conservationists who believe that humans can control and manipulate animal populations at will, and they see no cause for alarm until numbers drop below the magic 'minimum critical size'. They believe in the production model view of nature, which proposes that nature produces an annual surplus that is available for exploitation (Rogers 1994). As Rijksen (1995:19) points out in a critique of the conservation 'corporation', World Wildlife Fund, "Such an approach makes one anxious that a finding of more than 5000 orangutans may become the justification for further negligence". Numbers are useful in helping people visualise just how large or small a population is but care must be taken not to give the numbers more weight than the problem at hand. Whether there are 5,000 orangutans or 50,000, there still exists the problem of rapid habitat destruction and thus a correspondingly rapid decrease in the overall orangutan population. The problem must be dealt with before the situation is critical, and therein lies the flaw of traditional wildlife conservation- it only comes into play after the problem has become critical.

Failure of Orangutan Conservation Efforts

As discussed in Chapter Three, the most effective method of orangutan conservation would be habitat protection but habitat protection is given the least amount of attention. More prevalent by far are the following methods: orangutan rehabilitation, ecotourism, and education.

Orangutan Rehabilitation

In the early 1960's, it was believed that wild populations of orangutans were on the verge of collapse as a result of widespread poaching, and rehabilitation was proposed as a means of increasing the numbers of orangutans in the wild to ensure their survival. In 1962, Barbara Harrison was the first to begin attempts at rehabilitating orangutans, and ironically, her project in Bako National Park was considered a bad choice of location because there were no longer any wild orangutans living in the park (Rijksen 1982). As the original goal of rehabilitation centres was to restock the wild population, most of the first sites were established in areas where orangutans still lived in the wild. The orangutan population was not as badly depleted as originally thought, but several more centres were established over the next decade and rehabilitation continued to be used as a way to deal with confiscated animals, despite new evidence of the risk of disease transmission (Sugardjito and van Shaik 1992).

As government personnel began looking for and confiscating captive animals, the publicity attracted both local and international attention to the conservation problems. Even by the 1970's, however, people were beginning to see the shortcomings of the rehabilitation projects, and John MacKinnon argued that there were already too many orangutans for the quickly disappearing forest, that rehabilitants were potential transmitters of disease to wild populations, and that rehabilitation projects were not able to properly train the human-dependent orangutans to shun human contact and become arboreal so as to avoid predators (MacKinnon 1974, Maple 1980). By 1978, it was generally agreed at the Sixth Congress of the International Primatological Society that releasing ex-captives into wild populations was irresponsible and potentially harmful. It was also agreed that given that the main threat to orangutans was not poaching but habitat loss, the main goal of the rehabilitation was now conservation education and propaganda (Maple 1980). As such, the goals of the centres were supposed to shift from a focus on returning individuals to the wild to instead serving as educational facilities.

The social structure and solitary nature of orangutans have been described as conducive to rehabilitation (Aveling and Mitchell 1982). Orangutans are described as having an "open individualistic society" with a continuous, overlapping system of ranges in which adults keep social contacts to a minimum but subadults and adolescents do behave relatively socially (Rijksen 1974). While primates of any species require extensive training to become successfully rehabilitated, orangutans are considered to require less social training than the other great apes. Whether this is true or not is debatable, but it is the premise on which their rehabilitation was initially based and consequently early attempts neglected the importance of properly socialising the ex-captive orangutans.

The time and money spent rehabilitating ex-captive orangutans is necessary and admirable but ultimately rehabilitation is a band-aid solution which takes attention away from the larger problem of habitat destruction. It might soothe the human conscience to know that a few hundred individual orangutans are being given the chance of a new life in the forest, but it does not do much for the species as a whole. Orangutans will continue to be endangered until their habitat is protected. It is important to note that the governments and corporations so proudly funding these rehabilitation centres are also responsible for the deforestation that left the orangutans homeless in the first place. Logging operations, mining, agriculture and translocation schemes are all destroying the lowland primary forest ecosystems on which the future of the orangutans depend, yet this is overshadowed by the feel-good stories of rehabilitation successes. There was at one time a sizeable decrease in the open trade of orangutans after the inception of the rehabilitation centres (Aveling & Mitchell 1982), but there has since been a huge increase in habitat destruction. Suitable orangutan habitat in Indonesia and Malaysia is estimated to have declined by over 80% in the last 20 years and orangutan numbers have dropped by at least 30-50% (Soemarna et al. 1995).

Critics have accused governments of using rehabilitation centres to make themselves look good and to bring in money from tourism. For example, the Sepilok site in Sabah has been described as no more than a large public zoo and a public relations exercise for the government of Sabah (Peterson 1989). The Wanariset Orangutan Reintroduction Project, which prides itself on lack of tourism, has been ordered by the Indonesian government to begin phasing in ecotourism (Drewry 1996). It is in the best interest of the orangutans to keep tourism out but apparently the government is more interested in the financial profits they will gain from tourist dollars. The push to introduce tourism to the Sungai Wain Forest, a project already adequately financed by private and corporate donations (Drewry 1996) exposes the government's true interest in orangutan rehabilitation.

Ecotourism in Orangutan Rehabilitation Sites

Orangutan rehabilitation sites are popular tourist spots, yet orangutan rehabilitation centres located in areas subject to tourism cannot maintain the strict protection standards required for survival of an endangered species (Lardeux-Gilloux 1995). Along with the greatly increased risk of disease transfer from the contact with thousands of human visitors, the presence and contact with so many humans also interferes with the goal of teaching the orangutans to socialise with each other and adopt forest lives (Rijksen 1982).

The rehabilitation centres allow tourists to view orangutans, but they give a misleading impression of what an orangutan is and what they need for survival. The lives and importance of the bicultural orangutans who have been raised or spent time in the company of humans should not be diminished, but in order to save the orangutan species as a whole we must save the forest that made wild orangutans into such amazing creatures. There is even the possibility that the semi-wild rehabilitants will preclude the "need" for wild orangutans, just as zoos have taken away a great deal of the pressure to save animals in their natural environment. That the animals exist, even in a zoo, is enough for many people. As was expressed by Tom Harrisson, husband of Barbara Harrisson who ran the first rehabilitation centre for orangutans,

> Perhaps the captive orangs are no longer endangered, but, if the wild ones should disappear, will we really have saved the orangutan? Is the zoo inhabitant the same creature as the shy nomad of the rain forest?
> One man who knows the orangs well does not think so.... Harrisson mourned the life of an orangutan behind bars, To an Orang...there is dim hope where there is no tree, no butterfly, no flea! Orangs love and live for trees, leaves, mucking about, investigating, worrying, irregular rhythms, natural jokes. (Amon 1977:75).

The preservation of animals in zoos is, as Evernden (1993:13) argues, an "illusion of victory," for, while it may allow the continuation of the animal's genes, an animal consists of much more than genes. Following the same sentiment as Harrisson, Evernden wrote, "A solitary gorilla in a zoo is not really a gorilla; it is a gorilla-shaped imitation of a social being which can only develop fully in a society of kindred beings". (Evernden 1993:13). So it is with orangutans. The physical difference alone is overwhelming between captive and wild orangutans; captives generally being obese, unkempt, and prevented (by captivity) from participating in the aerial displays and food processing ingenuity that makes wild orangutans so unique (personal observation). One can well imagine the difference in mental health brought on by the constant boredom and confinement of such an intelligent species.

While rehabilitation centers are a step above zoos in that they do claim to have the reintroduction of orangutans to the wild as a goal, they are still guilty of perpetuating an inaccurate stereotype of orangutans, especially in places like Camp Leakey where tourists are both allowed and told to expect physical contact with the orangutans (Drewry 1996; Russell and Ankenman1996). Tourists generally appear to be much more interested in holding an orangutan, preferably a young one, than simply observing. As mentioned previously, allowing contact between humans and orangutans puts both at risk of disease transmission, and it can also be physically dangerous for the much weaker humans.

A recent documentary featured many shots of a famous actress cuddling orangutan babies at the rehabilitation centre known as Camp Leakey (located in Tanjung

Puting, Kalimantan and presided over by Birute Galdikas) gushing over how sweet they were and thus promoting a Disney-fied version of the orangutans. In one disturbing scene, the actress inched dangerously close to an adult male orangutan, who promptly grabbed her by the arm, pulled her towards himself, and gripped her neck in a stranglehold. Had their not been a sizeable group of humans there to pull her from the orangutan's arms while offering food in exchange for her release, the actress would quite likely have been seriously hurt, yet she brushed off the attack by claiming that the orangutan's intentions were friendly and that "he just wanted to smooch" (Tigress Productions 1998). That the filmmakers chose to include this scene is questionable, but that they included the actress' comment is totally irresponsible, especially as they edited out other scenes of experienced orangutan researchers discussing true orangutan nature. Also inexcusable is the behaviour of whoever was in charge at Camp Leakey during the filming, as the star and her film crew should never have been allowed to get so close to the orangutan. Portraying orangutans as ideal and happy human companions downplays the orangutans' need to live independently of humans in their rainforest home, and thus works against serious conservation efforts.

Education

There are several groups currently promoting the conservation of orangutans through educational and publicity campaigns, but they all include to one degree or another an acceptance of the continued exploitation of orangutans. The Orangutan Foundation International supports Galdikas and the rehabilitation centre Camp Leakey, thus supporting the exploitation of orangutans via tourism. The World Wildlife Fund has publicised the orangutan's plight, but they are also guilty of using the image of an orangutan to raise funds that did not go towards orangutan conservation (Rijksen 1995). The Wanariset Orangutan Reintroduction Project, as part of its move towards ecotourism, is opening an educational facility- but Smits has never commented on the role of habitat loss (as a result of deforestation and government forest policies) in the decline of orangutan numbers (Drewry 1996). The staff working with the orangutans are largely unaware of the importance of their work (personal observation); if Wanariset has failed to educate its own staff who work daily with the orangutans, it seems unlikely they will be able to enlighten tourists in a few short hours.

Failure of Rattan Conservation Efforts

Rattan conservation efforts have largely centred on the establishment of plantations and ignored wild populations (Bogh 1996, Peters 1996), thus exposing the bias towards conserving rattans for human use as opposed to protecting rattans for the sake of biodiversity. When wild populations are discussed it is in reference to their genetic potential for restocking plantations. The following statement is typical to rattan conservation in that the prime, and in fact only, concern is with rattan's continued profitability,

> Because only 20,000-25,000 ha of rattan plantations have been established in the region (South East Asia) so far, efforts should be made to protect and conserve representatives of rattan species and their natural habitats so that their future contribution toward the socio-economic development of the producing countries can be

> sustained. Genetic improvements and better cultivation techniques will certainly result in greater yields of rattans from plantations. (Soepadmo 1995:29).

Smallholder Rattan Cultivation

Smallholder rattan cultivation is promoted as beneficial for the following reasons: (1) as a climber, rattan requires arboreal support and hence clear-cutting of the forest is not necessary- thus promoting a more sustainable use of fragile lands and retaining habitat for other species. (2) it increases and diversifies the income of rural and forest people, (3) rattan exports generate significant foreign exchange, and (4) it creates many employment opportunities and is important to local economies (Godoy and Feaw 1989). In addition, rattan is naturally occurring and can be grown without pesticides or fertilisers; harvesting rattan does not cause soil erosion; and it has been claimed that its introduction does not upset the ecological balance of the forest (International Network for Bamboo and Rattan 1996). These benefits have led several international donor organisations, such as the IDRC and USAID, to promote smallholder rattan cultivation in areas of Asia and Latin America.

While these "benefits" sound promising, they have serious flaws. The idea that rattan cultivation will provide habitat for other species sounds good in theory but in practice the very species who depend most on rattans as a food source will not be welcome in these areas as they will be in direct competition with humans for the rattan. Orangutans, for example, can cause enough damage to rattans while eating them so as to make them commercially useless, thus making themselves destructive pests in the eyes of rattan cultivators. The claim that the introduction of rattan will not upset the ecological balance of a forest is false because the introduction of any new species will automatically change the existing balance of the ecosystem.

As far as local economies and employment are concerned, there is a growing gap between large producers and the rural market base. The rattan industry in Borneo, for example, began as a rural cottage industry and was then encouraged by local officials as it developed and expanded to include access to the Japanese market. However, tighter restrictions on quality and export regulations have led to an increasing concentration of urban factories. As resources become less abundant, the trend towards centralisation continues, which in turn increases inequalities and reduces local opportunities (Brookfield et al 1995).

Intensive Rattan Cultivation:

Rattan is promoted as ideal for intensive cultivation and management. The reasons are as follows: (1) relatively rapid growth rates as compared to other forest products such as timber (canes can be harvested in 8-10 years), (2) good growth potential at high stocking densities, (3) readily germinated seeds, (4) capacity to sprout after cutting, (5) good growth in primary and secondary forests, and (6) harvesting possible with little or no soil erosion. However, it must be noted that not all species exhibit all of these traits (Siebert 1987). The above characteristics describe the multi-stemmed species of rattan, but it is the single-stemmed species which are most sought after commercially. There has been some success with small and medium sized canes, but cultivation of the large diameter single-stemmed species like *Calamus manan* has proven to be quite difficult, especially as they are unable to regenerate after cutting (Kartinawata et al 1983). The cultivation of a species like *C. manan* might be economically viable if the canopy was manipulated to provide optimal light regimes but it would still require replanting after every harvest and it would also require well developed primary or secondary forest to support the large stems (Siebert 1991).

Again, as with the rattan/swidden system, these options can be sustainable only when done on a small scale. It seems unlikely that the same governments who have actively promoted massive clearcuts of timber will now be content with exploiting another resource on a small, local and ecologically sound scale. Regardless of whether or not rattan cultivation proves to be ecologically sound, if it proves to be financially profitable it will likely be adopted on a large scale.

Experiments are already under way with huge plantations of thousands of hectares of rattan. In Sabah, a 7400-hectare plantation of rattan was established in 1988 as part of a plan to convert "marginal" land to productive forestry use (Cleary and Eaton 1992). By 1980, 30,000 hectares of forest on China's Hiana Island had been planted with 20 million rattan seedlings; and in the Philippines experiments are under way planting rattan seedlings in large areas of logged forest (Dransfield and Manokaran 1993). Rattan is also being planted as a cash crop for settlers in Indonesia's huge transmigration project (Brookfield et al 1995).

Rattan as cultivated traditionally does not require pesticides. It has been claimed that rattan has few pests, but infestations have already begun to occur on the new plantations, such as the *Calamus manan* plantations in Sabah hit by an outbreak of rhinoceros beetles (Dransfield and Manokaran 1993). Rattans grown on plantations appear to attract insect pests that are not commonly associated with wild rattan populations (Steiner and Mohammad 1997). As with any plant or animal, genetic diversity cannot be maintained in cultivation and it will eventually deteriorate. The genetic base for commercial development has already been seriously depleted by over collection in the wild (Stewart 1994). Humans simply do not know enough about rattan or rattan's relationship with other species to be advocating the adoption of large-scale plantations.

---

[i] There is currently a sustainable development project operating in West Kalimantan that is encouraging the collection, processing and marketing of rattans. Funded by the Biodiversity Conservation Network, this project has been in operation for 10 years yet it does not know how many "rattan clumps there are, their growth rate, or how much can be harvested. We do not know what to base the calculations on to determine the potential yield of each non-timber product. Our dream—knowing what the sustainable harvest level is—is still far off, and maybe we won't know for another year or two" (BCN Website "Forest Products in the Rain Forest of West Kalimantan, Indonesia" July 16, 1998). One wonders what will become of the rattan populations in that area.

CHAPTER EIGHT: CONCLUSION

Summary of Results

The results of the investigation of the relationship between orangutans and rattans suggest that (i) rattans are an important food source for orangutans; (ii) orangutan predation causes damage to rattans; and (iii) rattans appear able to recover from the most frequent form of orangutan damage. These results highlight the importance of food availability to the success of orangutan reintroduction projects and also highlight the need for integrated rattan research that takes into account rattan's relationship with other forest species.

On a larger scale, this thesis has examined the importance of biodiversity and the failure of current wildlife and botanical methods to effectively protect Nature. The Indonesian example of rapid economic growth resulting in massive deforestation and ecological destruction is not unique, but many of the species threatened by the Indonesian crisis are unique. Wild orangutans live only on the islands of Borneo and Sumatra, as do many species of rattan, and their very existence is now at risk. Current conservation projects are not able to effectively protect orangutans or rattans from further human exploitation in part because they do not challenge the assumption that Nature exists for human utilisation and also because they lack financial and political power. So long as forests are considered "natural resources", they and all their inhabitants will be at risk. The financial burden of protecting orangutans and rattans should not be shouldered by Indonesia alone- the so-called developed countries advocating the protection of endangered species must contribute financial, as well as practical (education, training and technical), support.

Recommendations

Orangutan and Rattan Conservation: The protection of habitat is crucial to the survival of orangutans and rattans in the wild; conservation efforts should thus concentrate on ensuring that wild populations are adequately protected against human encroachment. Although strict protection is not a popular option, it is the only viable option for certain species. History has proven that orangutans and humans cannot live together in the same forest habitat (Rijksen 1995). Areas designated for the protection of orangutans must restrict human activities. In the aftermath of the 1998 fires that destroyed much of the Sungai Wain Forest, there has been discussion amongst the Wanariset-Tropenbos team about fencing in the remaining forest (Russon personal communication).

The survival of endangered rattan species is also dependent upon habitat protection. The harvesting of rattan is not ecologically benign; thus rattans should not be promoted as a "sustainable" option to timber harvesting. So little is known about the ecology of rattans and their role within forest ecosystems that it is irresponsible to encourage their continued exploitation.

Wildlife and Botanical Conservation: The most important step that humans can take to protect wild species, such as orangutans and rattans, is to change the way in which humans view Nature. The adoption of the ideals of biological conservation would result in a world which values life in all forms, respects wilderness, and appreciates the human role as being within, not outside of, Nature. Humans need to re-establish an emotional bond with the natural world and let go of the false belief that animals, plants, minerals and the Earth itself exist for human use. Efforts to protect endangered species and places will not be successful until humans learn to truly appreciate the right of others to exist for their own sake. Such an appreciation may take years to many years to develop and so, in the interim, endangered species and spaces need to be protected from humans.

What is needed is the acceptance of the basic tenet of biological conservation, which proposes that other life forms be preserved and protected for their own sake, not for human utility or benefit. Humans must let go of the notion that nature exists for them to use as they see fit. "Developing" countries should be shown what an environmental, social and even economic disaster that economic development has been for the Western world. Economic development thus far has been based on the exploitation of natural resources; it is unsustainable, environmentally destructive and has not succeeded in eliminating poverty (Frazier 1997).

While it is useful and necessary to critique the existing models of wildlife and botanical conservation, one should not use their failure to meet the standards of biological conservation as an excuse to withdraw from them entirely. Biological conservation is a crisis discipline and the ecological crisis currently facing the Earth requires immediate action. Wildlife conservation is indeed inherently flawed, yet the time required to achieve the necessary shift in thinking to “fix” its philosophy would far surpass the time remaining for wildlife without the parallel efforts of current, albeit misguided, conservationists. The same holds true for botanical conservation, especially as the notion that plants exist for human utilisation is even more firmly entrenched in modern thought than the notion of animals existing for human use.

The ultimate survival of wild plants and animals will depend on humanity's adoption of the biophilic ideals of biological conservation, but, in the meantime, their survival requires the continued work of current conservation programmes. By working within and/or alongside the existing conservation framework, supporters of biological conservation can influence and educate other individuals and improve conservation projects while concurrently taking concrete action to protect wild animals, plants, and Nature itself. The physical protection of wilderness is paramount and it must occur now, even before humanity has re-established an emotional connection with the wild, if there is to be wilderness left at all.

Future research

The study conducted for the purposes of this thesis can be seen as a starting point for several other areas of research. First, as this study was conducted over a relatively short three-month period that coincided with a severe drought, it would be interesting to conduct a long-term study of the orangutan-rattan relationship in the Sungai Wain Forest that would track any changes through various seasons and weather conditions. While it is clear that rattan is an important food source during the dry season when fruit and other foods are scarce, it would be useful to learn what role rattan plays in orangutan diets over the course of a longer study cutting across other seasonal variations.

To investigate the orangutan-rattan relationship further, it would be interesting to conduct nutritional and pharmacological analyses of the various rattan species consumed by the orangutans of Sungai Wain Protected Forest. Some species may have more nutritional value than others and certain species may prove to have important medicinal properties. Such biochemical analyses would help explain why the orangutans of Sungai Wain eat rattans and what benefits they receive (if any) beyond simple food energy. Especially in times of stress, like drought, these medicinal benefits may themselves be important for survival.

It would also be useful to investigate other orangutan-food relationships in the Sungai Wain Forest in order to assess whether or not the forest is indeed capable of supporting its orangutan population. Although orangutans are living there currently, it has not been established that their presence is within the long-term carrying capacity of the forest. The compilation of a complete inventory of orangutan foods in the area would be useful both to the Wanariset Orangutan Reintroduction Project and to all future orangutan reintroduction projects. Based on studies done so far, it appears that the orangutans of Sungai Wain consume a somewhat different diet than orangutans studied in other areas (Peters 1995). For example, rattan is an important food source in Sungai Wain but it is only mentioned as a minor or supplementary food source in other areas such as Tanjung Puting (Galdikas 1988). The creation of a complete inventory for the Sungai Wain Forest, and subsequently other areas in Indonesia inhabited by orangutans, would help clarify why these differences exist and also serve as a checklist of sorts for potential release sites.

This study is one of the first to examine the relationship of rattan with other species; so, there are numerous other studies to be done on all the various relationships that different rattan species have with other animals, plants, and insects. As rattan is so popular in current "sustainable" development plans, it is vital that its true role within rainforest ecosystems is better understood so that humans do not destroy that which they wish to "sustain". Harvesting rattan may ultimately prove to be as destructive to the forest as harvesting timber. Switching from one "natural resource" to another does not solve the problem at hand: humans need to deal with the root problem of over-exploitation of the Earth's lands, seas, plants, and animals.

EPILOGUE:
THE FOREST FIRES OF 1997/98

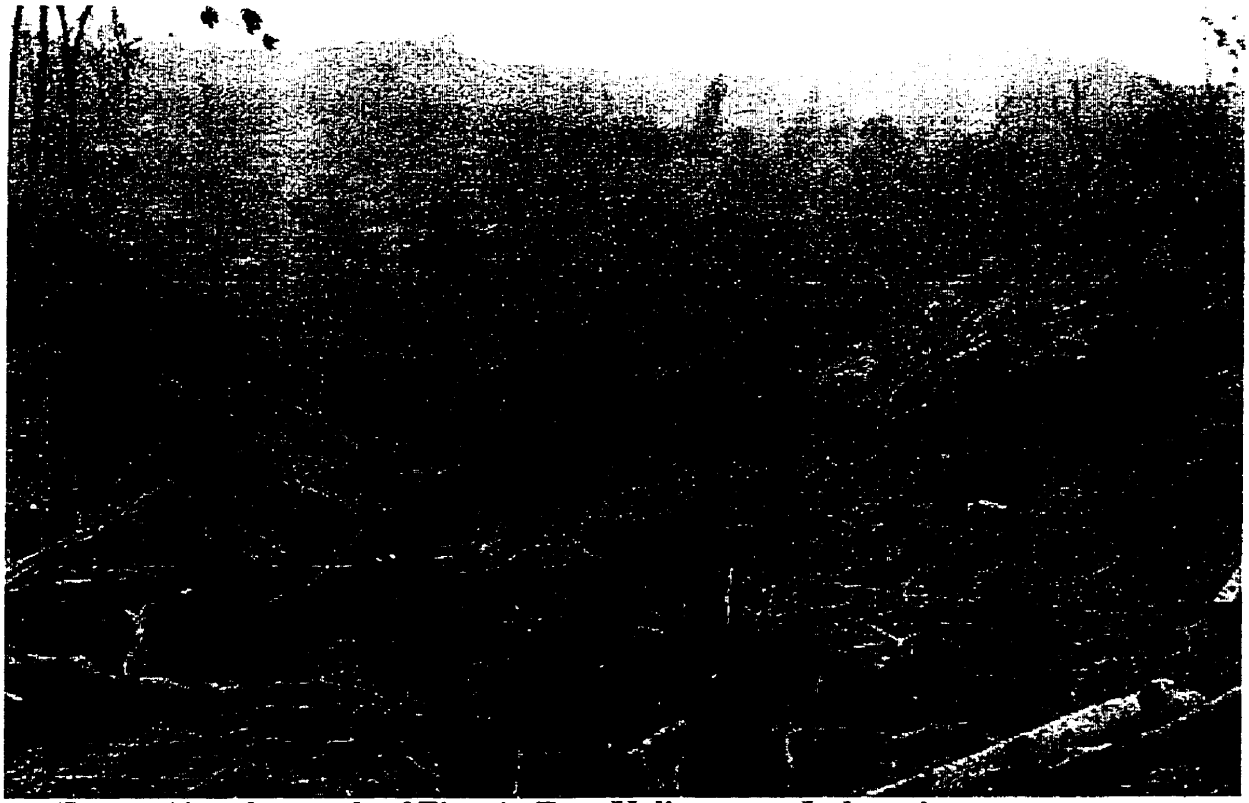


Figure 12: Aftermath of Fires in East Kalimantan, Indonesia
Photo: Elke Meyfarth

The widespread forest fires of 1997-98 proved to be an ecological, economic and social disaster for Indonesia. Massive corruption, greed and ineffectual bureaucracy came together in a deadly mixture that resulted in a billion-dollar environmental disaster. The failure of the government to react to the crisis or even admit their role in its creation only cemented their guilty position. As one observer commented, "...Borneo is burning while Suharto fiddles" (Muirthile 1997). Suharto has since been forced to step down from his role as President, but the effects of his regime have crippled Indonesia and will be felt for many years to come.

Much of the initial media coverage of the Indonesian fires attributed their start to the weather pattern known popularly as El Nino. Azwar Anas, the Indonesian official responsible for disaster co-ordination, blamed the forest fires squarely on El Nino, claiming that "It's a natural disaster that no one could have prevented" (Ajello 1997). In truth, however, humans caused the fires. According to the Integrated Forest Fire Management Project (a joint collaboration between the German and Indonesian governments), the El Nino Southern Oscillation causes very dry weather conditions in Indonesia every 3-5 years, during which time a fire season does usually occur- but the fires are almost always human caused (IFFM 1998). A massive fire burned 5 million hectares of Borneo's tropical rain forests in 1982-83, and large scale fires have since reoccurred on Borneo and Sumatra in 1986, 1991, 1994 and now 1997-98 (IFFM 1998).

A very small percentage of the fires are set by small farmers and shifting cultivators, while the lion's share is set deliberately by timber and plantation industries. Indonesia's minister of agriculture, Syarifudin Baharsyah, stated that plantations caused some 80 percent of the forest fires (Anonymous 1997). Before last year's economic crash, Indonesia had the strongest economy in South East Asia: a position it achieved by vigorously exploiting its natural resources. In order to increase the "development" over the last few years, the government has been granting subsidies and permits to clear vast areas of land in Borneo and Sumatra to timber, palm oil and rubber plantation companies. The least expensive method of clearing forest and swampland is to simply burn it, and despite a 1995 ban on the practice, it still continues. According to one plantation sector analyst, "Everyone knows that this isn't supposed to go on, but poorly paid agriculture and forestry inspectors just need to be given a bribe and they forget it's happening" (Choong 1997). The opening of the forest canopy as a result of logging leads to the drying out of forests that would normally not burn, and so fires started in nearby plantations are quick to catch on in the surrounding forest areas. Large areas of land have also been cleared by burning for settlements of the government's controversial Transmigrasi program, as have large areas of peat swamp forest in Kalimantan for the Mega Rice Project.

Indonesia's neighbours have grown accustomed to the now yearly "haze" caused by the illegal burning of the forests, but they are becoming increasingly irate. In 1997 the smoke from the countless fires reached past Indonesia and into Malaysia, Thailand, the Philippines, Singapore, and Brunei. In other years, the start of the rains in September had helped to dampen the fires but in 1997 conditions were extremely dry and the rains did not come until the end of November. The resulting pollution from the smoke of countless fires affected millions of people. Respiratory problems, headaches, nausea, burning eyes, and the possibly carcinogenic effects of months of inhaling respirable suspended particles. Scientists do not yet know the long-term effects, but at least one respiratory specialist interviewed was eager to investigate the effects of such unusual circumstances on human health (Mok 1997).

Despite the vast environmental destruction and far-reaching health threats, the Indonesian government was extremely slow to react and by the time they did, the fires were completely out of control. The fires eventually died out in early July 1998; by which point the catastrophe had cost the Indonesian government billions of dollars. The total damages for 1997 alone are estimated at US$4.5 billion dollars (Economy and Environment Programme for South East Asia /EPSEA and World Wildlife Fund/WWF 1998).

Sungai Wain Forest, in which this study was set, was reduced to less than 4,000 hectares (from a pre-fire size of approximately 11,000 hectares) after fires in March and April of 1998. A few of the resident orangutans have been observed in the remaining forest but others have vanished (Russon personal communication). Such a loss in an already small patch of forest will have dire consequences for the surviving orangutans and other wildlife. During the study period the orangutans already seemed hard-pressed to find enough food; with drastically shrunken resources the next period of drought may be deadly.

REFERENCES

Abang Morshidi, A.H. and Gumal, M.T. (1995). "The role of totally protected areas in preserving biological diversity in Sarawak". In Primack, R. and Lovejoy, T.E. (eds.) *Ecology, Conservation, and Management of Southeast Asian Rainforests*, pp.204-220. New Haven: Yale University Press.

Adams, W.M. (1990). *Green Development: Environment and Sustainability in the Third World.* London: Routledge.

Ajello, R. (1997). "The Bad Boy is Back", *Asiaweek*, October 10.

Amon, A. (1977). *Orangutan: Endangered Ape*. New York: Antheneum.

Anonymous. (1998). "Mega-project under fire", *Down to Earth (International Campaign for Ecological Justice in Indonesia)* (37), World Wide Website: http://forest.lic.wisc.edu/ric/wrr39/megarice.htm. (1998, May 10).

Anonymous. (1997). "Forests of Borneo going up in smoke", *The Guardian*, September.

Anonymous. (1997). Untitled. *Asiaweek*, October 10.

Anonymous. (1995). "Forest people", *The Economist* 336(7924), 76-79.

Ave, W. (1988). "Small-scale utilization of rattan by a Semai community in West Malaysia", *Economic Botany* 42, 105-19.

Aveling , R.A. & Mitchell, A. (1982). "Is rehabilitating orangutans worthwhile?", *Oryx* 16, 263-271.

Balikpapan Orangutan Society. (1998). World Wide Website: http://www.redcube.nl/bos/index.htm. (1998, June 20).

Balikpapan Orangutan Society/USA. (1998). *Voices from the Wilderness* 1 (1). Newsletter.

Banarjee, A.K. (1995). *Rehabilitation of Degraded Forests in Asia*. Washington: The World Bank.

Barber, C.V. (1997). *Environmental Scarcities, State Capacity, and Civil Violence: The Case of Indonesia*. Cambridge: American Academy of Arts and the University of Toronto.

Barbier, E., Bockstael, N., Burgess, J. and Strand, I. (1994). "The timber trade and tropical deforestation in Indonesia". In Brown, K. and David W. Pearce (eds.) *The Causes of Tropical Deforestation.* London: UCL Press Ltd.

Barrow, C.J. (1995). *Developing the Environment: Problems and Management.* Singapore: Longman Scientific and Technical.

Barry, D. and Oelschlager, M. (1996). "A science for survival: Values and conservation biology". *Conservation Biology* 10(3), 905-911.

Bevis, W.W. (1995). *Borneo Log: The Struggle for Sarawak's Forests.* Seattle: University of Washington Press.

Biodiversity Conservation Network. (1998). "Forest Products in the Rain Forest of West Kalimantan, Indonesia". World Wide Website: http://bcnet.org/text/projects/kalimantanfps97_3.htm. (1998, July 16).

Bogh, A. (1996). "Abundance and growth of rattans in Khao Chong National Park, Thailand", *Forest Ecology and Management* 84, 71-80.

Brookfield, H., Potter, L. and Byron, Y. (1995). *In Place of the Forest: Environmental and Socio-Economic Transformation in Borneo and the Eastern Malay Peninsula.* Toyko: United Nations University Press.

Caldecott, J. (1988). "Climbing towards extinction", *New Scientist* 118, June 9, 62-6.

Charras, M. and Pain, M. (1993). *Spontaneous Settlements in Indonesia.* Jakarta: Departemen Transmigrasi.

Choong, T.S. (1997). "The reckless torching of Indonesia's forest lands". *Asiaweek*, October 10.

Cleary, M. and Eaton, P. (1992). *Borneo: Change and Development.* Singapore: Oxford University Press.

Cohen, L. and Holliday, M. (1982). *Statistics for Social Scientists.* London: Harper & Row Ltd.

Colchester, M. and Lohmann, L. (eds.). (1993). *The Struggle for Land and the Fate of the Forests.* London: Zed Books Ltd.

Corner, E.J.H. (1971). *The Natural History of Palms.* London: Weidenfeld and Nicholson.

DiCastri, F., Baker, F.W.G. and Hadley, M. (1981). *Ecology in Practice: Part I Ecosystem Management.* Dublin: Tycooly International Publishing Limited.

Dransfield, J. (1992). *The Rattans of Sarawak.* Royal Botanical Gardens, Kew and Sarawak Forest Department.

____. (1988). "Raising cane: the natural history of the rattan race", *New Scientist*, 118, June 9, 64.

____. (1981). "The biology of Asiatic rattans in relation to the rattan trade and conservation". In Synge, H. (ed.) *The Biological Aspects of Rare Plant Conservation*, 179-186. Wiley and Sons, New York.

Dransfield, J. and Manokaran N. (eds.). (1993). *Plant Resources of South-East Asia No. 6: Rattans.* Wangeningen: Pudoc Scientific Publishers.

Drewry, R. (1996). *Sustainable Development, Ecotourism and Flagship Species: The Case of Orangutan Ecotourism in Indonesia.* Murdoch University. Unpublished B.A. thesis.

Economy and Environment Programme for South East Asia (EPSEA) and World Wildlife Fund (WWF). (1998). "The Indonesian Fires and Haze of 1997: The Economic Toll". World Wide Website: http://www.idrc.org.sg/eepsea/fire.htm. (1998, June 4).

Ehrenfeld, D.W. (1970). *Biological Conservation.* New York: Holt, Rinehart and Winston, Inc.

Eudey, A.A. (1995). "The impact of socio-economic decisions on the status of the orangutan and other East Asian fauna". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*, pp. 23-27. New York: Plenum.

Evernden, N. (1993). *The Natural Alien.* Toronto: University of Toronto Press. Second Edition.

Frazier, J.G. (1997). "Sustainable development: modern elixir or sack dress?", *Environmental Conservation* 24(2), 182-193.

Galdikas, B.M.F. (1988). "Orangutan diet, range, and activity at Tanjung Putting, Central Borneo", *International Journal of Primatology* 9, 1-36.

Godoy, R.A. and Feaw, T.C. (1989). "The profitability of smallholder rattan cultivation in southern Borneo, Indonesia", *Human Ecology* 17, 347-63.

Goudie, A. (1990). *The Human Impact on the Natural Environment (Third Edition)*. Cambridge: The MIT Press.

Grieser Johns, A. (1997). *Timber Production and Biodiversity Conservation in Tropical Rain Forests*. Cambridge: Cambridge University Press.

Hardjono, J.M. (ed.) (1991). *Indonesia: Resources, Ecology and Environment*. Singapore: Oxford University Press.

Hardter, R., Chow, W.Y., and Hock, O.S. (1997). "Intensive plantation cropping, a source of sustainable food and energy production in the tropical rain forest areas in Southeast Asia", *Forest Ecology and Management* 91(1), 93-102.

Howell, D.C. (1985). *Fundamental Statistics for Behavioral Sciences*. Boston: PWS Publishers.

Hurst, P. (1990). *Rainforest Politics: Ecological Destruction in South-East Asia*. London: Zed Books Ltd.

Indonesia Maps. (1998). World Wide Website: http://home.1swipnet.se/~w-15266/indons/maps/index.htm. (1998, June 20).

Indonesian National News Agency. (1998). "Habibie: RI's Population to Reach 310 Million by 2050". World Wide Website: http://www.antara.co.id/currissue/98/7/13/E12.html. (1998, July 13).

Indonesian Nature Conservation Database. (1998). "Red List". World Wide Website: http://www.noord.bart.nl/~edcolijn/index.html. (1998, July 20).

Integrated Forest Fire Management. (1998). "Causes of Forest Fires", World Wide Website: http://smd.mega.net.id/iffm/Background.html. (1998, April 21).

International Network for Bamboo and Rattan (INBAR). (1998). World Wide Website: http://www.idrc.org.sg/inbar/index.html. (1998, June 20).

___. (1996). "Evaluation Report: May 1996". World Wide Website: http://www.idrc.ca/library/document/104800/index_e.html#Biodiversity,Genetic Resources and Conservation. (1998, June 20).

International Peat Society (IPS). (1997, November 3). "Fight the Fires Save the Peatland!", World Wide Website: http://www.peatsociety.fi/news/pressrel.htm. (1998, April 21).

International Primate Protection League (IPPL). (1998). "Indonesia Burning: Coverage of Fires- ABC News, October 11, 1997". World Wide Website: http://www.ippl.org/ippl-news.html (1998, April 22).

International Tropical Timber Organization (ITTO). (1997). "Bamboo & Rattan: Resources for the 21st Century?", *Tropical Forest Update*. 7(4).

International Union for Conservation of Nature and Natural Resources (IUCN). (1980). *World Conservation Strategy*: Living Resource Conservation for Sustainable Development.

IRIP News Service. (1998). "Politics and Peat: The one million hectare sawah project", Inside Indonesia World Wide Website: http://www.serve.com/inside/edit48/1juta.htm. (1998, November 23).

Jacobson, S.K. (ed.). (1995). *Wildlife Conservation Through Education*. New York: Columbia House.

Jepma, C.J. (1995). *Tropical Deforestation: A Socio-Economic Approach*. London: Earthscan Publications Ltd.

Johnson, D. (ed.) (1996). *Palms: Their Conservation and Sustained Utilization*. Salisbury: IUCN/SSC Palm Specialist Group.

Jones, D.L. (1994). *Palms Throughout the World*. Washington: Smithsonian Institution Press.

Junaid, H. (1997, October 10). "Another Disaster Looms in Indonesia", Worldwide Forest/Biodiversity Campaign News World Wide Website: http://forest.org/gopher/indonesia/megarice.txt. (1998, April 21).

Kaiser, Robert G. (1997). "Forests of Borneo Going Up in Smoke", *The Guardian*, September.

Kartinawata, K., Jessup, T.C., and Vadya, A.P. (1983). "Exploitation in Southeast Asia". In Lieth, H. and Werger, M.J.A. (eds.) *Ecosystems of the World 14B- Tropical Rain Forest Ecosystems: Biogeographical and Ecological Studies*, 591-610. Amsterdam: Elsevier.

Knott, C. (1998). "Orangutans in the wild", *National Geographic* 194(2), 30-57.

Kuznik, S. (1997). "How to be an orangutan", *International Wildlife* 27(1), 38-43.

Lammerts van Bueren, E.M. and Duivenvoorden, J.F. (1996). *Towards Priorities of Biodiversity Research in Support of Policy and Management of Tropical Rain Forests.* Wageningen: The Tropenbos Foundation.

Lardeux-Gilloux, I. (1995). "Rehabilitation centers: Their struggle, their future". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*, pp.61-68. New York: Plenum.

Leighton, M. et al.(1995). "Orangutan life history and Vortex analysis". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*. pp.97-107. New York: Plenum.

Leiman, A. and Ghaffar, N. (1996). "Use, misuse and abuse of the orang utan - exploitation as a threat or the only real salvation?" In Taylor, V.J. and Dunstone, N. (eds.) *The Exploitation of Mammal Populations* , pp.345-357. London: Chapman & Hall.

Livingston, J.A. (1994). *Rogue Primate: An Exploration of Human Domestication.* Toronto: Key Porter Books.

____. (1981). *The Fallacy of Wildlife Conservation.* Toronto: McClelland and Stewart Limited.

Mabberly, D.J. (1992). *Tropical Rain Forest Ecology.* Glasgow: Blackie & Son Ltd.

MacKinnon, J. (1974). *In Search of the Red Ape.* London: William Collins Sons & Co Ltd.

Maple, T. (1980). *Orang-Utan Behavior.* New York: Van Nostrand Reinhold Company.

Massey, R. (1990). "Rainforest logging poses problems for wood industry: Finnish visitors say Indonesia's plywood industry has adequate technology for its goal of creating jobs, but think it needs to improve its environmental image". *World Wood* 31(4), 42-44.

McNeely, J., Miller, K.R., Reid, W.V., Mittermeier, R.A. and Werner, T.B. (1990). *Conserving the World's Biological Diversity.* Washington: IUCN, WRI, CI, WWF, and the World Bank.

Meyer, J.L. and Helfman, G.S. (1993). "The ecological basis of sustainability". *Ecological Applications* 3(4), 569-571.

Mok. (1997). *Asiaweek.* October 10.

Muirthile, S. O. (1997). "Letter to the Editor", *The Irish Times*, October 6.

Muntingh, H. (1997, October 17). "The Mega-Rice Project in Central-Kalimantan: Forest Fires and the Fate of Wildlife", Worldwide Forest/Biodiversity Campaign News World Wide Website: http://forests.org/gopher/indonesia/megarice.txt. (1998, April 21).

Napier, J.R. and Napier. P.H. (1985). *The Natural History of the Primates*. The MIT Press: Cambridge.

National Development Information Office. (1992). *Indonesia Sourcebook 1992*. Republic of Indonesia.

Parker, S.T. and Russon, A.E. (1996). "On the wild side of culture and cognition in the great apes". In Russon, A.E., Bard, K.A. and Parker, S.T. (eds.) *Reaching into Thought: The Minds of the Great Apes*, pp. 431-450. Cambridge: Cambridge University Press.

Pearce, D. and Brown, K. (1994). "Saving the world's tropical forests". In Potter, D. (ed.) *NGOS and Environmental Policies: Asia and Africa*. London: Frank Cass & Co. Ltd

Peters, C.M. (1996). *The Ecology and Management of Non-Timber Forest Resources*. Washington: The World Bank.

Peters, H. (1995). *Orangutan Reintroduction: Development, Use and Evaluation of a New Method.* University of Gronigen. Unpublished M.Sc. thesis.

Peterson, D. (1989). *The Deluge and the Ark: A Journey into Primate Worlds*. Boston: Houghton Mifflin Company.

Petrich, C.H. (1993). "Indonesia and global climatic change negotiations: Potential opportunities for and constraints for participation, leadership and commitment". *Human and Policy Dimensions* 3, 53-77.

Piper, J.M. (1992). *Bamboo and Rattan: Traditional Uses and Beliefs*. Singapore: Oxford University Press.

Poore, D. and Sayer, J. (1991). *The Management of Tropical Moist Forest Lands: Ecological Guidelines*. Cambridge: IUCN-The World Conservation Union.

Potter, D. (1996). "Democratisation and the Enironment: NGOs and deforestation policies in India (Karnataka) and Indonesia (North Sumatra)". In Potter, D. (ed.) *NGOS and Environmental Policies: Asia and Africa*. London: Frank Cass & Co. Ltd.

Primack, R. and Lovejoy, T.E. (eds.). (1995). *Ecology, Conservation, and Management of Southeast Asian Rainforests*. New Haven: Yale University Press.

Rice, T. and Counsell, S. (1993). *Forests Foregone: The European Community's Trade in Tropical Timbers and the Destruction of the Rainforests*. London: Friends of the Earth Ltd.

Rickson, F.R. and Rickson, M.F. (1986). "Nutrient acquisition facilitated by litter collection and ant colonies on two Malaysian palms". *Biotropica* 18, 337-43.

Rijksen, H.D. (1995). "The neglected ape?". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*, pp.13-21. New York: Plenum

____. (1986). "Conservation of orangutans". In Benirschke, K (ed.) *Primates: The Road to Self-Sustaining Populations*, pp.153-159. New York: Springer-Verlag.

____. (1982). "How to save the mysterious 'man of the forest'?". In L.E.M.De Boer, (ed.) *The Orangutan: Its Biology and Conservation*. The Hague: Dr. W. Junk Publishers.

____. (1974). "Orangutan conservation and rehabilitation in Sumatra". In Kondo, S., Kawai, M., and Ehara, A. (eds.) *Contemporary Primatology*, pp.373-379. Basel: S. Karger.

Rodman, P.S. (1977). "Feeding behavior of orang-utans in the Kutai Nature Reserve, East Kalimantan". In Clutton-Brock, T.H. (ed.) *Primate Ecology*, London: Academic Press.

Rogers, R.A. (1994). *The Oceans are Emptying: Fish Wars and Sustainability*. Montreal: Black Rose Books.

Russell, C.L. and Ankenmann, M.J. (1996). "Orangutans as photographic collectibles: Ecotourism and the commodification of nature", *Tourism Recreation Research* 21(1), 71-78.

Russon, A. and Erman, A. (1996). *Nest Count Surveys of Orangutans (Pongo pygmaeus pygmaeus) in and around the Danau Sentarum Wetlands Reserve West Kalimantan, Indonesia*. Unpublished report to PHPA and Wetlands International-Indonesia.

Sachs, W. (1996). "Neo-Development: Global ecological management". In Mander, J and Goldsmith, E. (eds.) *The Case Against the Global Economy*. San Francisco: Sierrra Club Books.

Sekretatriat Kerjasama Pelstarian Hutan Indonesia/NGO Network for Forest Conservation in Indonesia (SKEPHI). (1998). "The Indonesian Mega Rice Project", Worldwide Forest/Biodiversity Campaign News World Wide Website: http://forest.org/gopher/indonesia/ricfilm.txt. (1998, August 20).

Shiva, V. (1995). "Foreword". In Vandermeer, J. and I. Perfecto. *Breakfast of Biodiversity: The Truth about Rain Forest Destruction*, p.ix. Oakland: The Institute for Food and Development Policy.

____. (1992). "Recovering the meaning of sustainability". In Cooper, D.E. and J.A. Palmer (eds) *The Environment in Question*, pp.87-93. London: Routledge.

Siebert, S.F. (1991). "Biology, utilization and silvacultural management of rattan palms". In Putz, F.E. and Mooney, H.A. (eds.) *The Biology of Vines*, pp. 477-492. Cambridge University Press, Cambridge.

____. (1987). "Land use intensification in tropical uplands: Effects on vegetation, soil fertility and erosion". *Forest Ecology and Management* 21(1-2), 37-56.

Smits, W.T.M., Heriyanto, and Ramono, W.S. (1995). "A new method for rehabilitation of orangutans in Indonesia: A first overview". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*, pp.69-78. New York: Plenum.

Soemarna, K., Ramano, W., and Tilson, R. (1995). "Introduction to the Population and Habitat Viability Analysis Workshop". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*, pp.81-83. New York: Plenum.

Soemarna, K., Ramano, W., Poniran, S., van Shaik, C.P., Rijsken, H.D., Leighton, M., Sajuthi, D., Lelana, A., Karesh, W., Griffiths, M., Seal, U.S., Traylor-Holzer, K. and Tilson, R. (1995). "Conservation Action Plan for orangutans in Indonesia". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*. pp.123-128. New York: Plenum.

Soepadmo, E. (1995). "Plant diversity of the Malesian tropical rainforest and its pytogeographical and economic significance". In Primack, R. and Lovejoy, T.E. (eds.) *Ecology, Conservation, and Management of Southeast Asian Rainforests*, pp.19-53. New Haven: Yale University Press.

Southeast Asian Science Policy Advisory Network. (1998). "There will be no celebrations in Asia, if loans are not made conditional upon environmental issues", World Wide Website: http://www.icsea.or.id/sea-span/0497/eg0421ll.htm. (1998, April 17).

Steiner, H. and Mohamad, A. (1997). "Survey of Hesperids found on Calamus manan in a natural forest and three types of plantation". Journal of Tropical Forest Science 10(2), 256-261.

Stewart, L. (1994). *A Guide to Palms and Cycads of the World*. London: Cassell Publishers Ltd.

Sugardjito, J. (1995). "Conservation of orangutans: Threats and prospects". In Nadler, R., Galdikas, B.F.M, Sheeran, L.K., and Rosen, N. (eds.) *The Neglected Ape*, pp. 45-50. New York: Plenum.

Sugardjito, J. & Van Shaik, C.P. (1992). "Orangutans: Current population status, threats and conservation measures". In *Proceedings of the Conservation of the Great Apes in the New World Order of the Environment*, Dec. 15-22, 1991, pp. 142-152. Published by the Ministries of Forestry and Tourism, Post and Telecommunications, Republic of Indonesia.

Suplee, C. (1995). "Earth's biotic wealth faces unprecedented threat". *The Washington Post*. Nov. 20.

Szaly, F.S. (1979). *Evolutionary History of the Primates*. New York: Academic Press.

Tigress Productions (1998). *In the Wild: Orangutans with Julia Roberts*. Aired May 20, 1998.

Tomlinson, P.B. (1990). *The Structural Biology of Palms*. Oxford: Clarendon Press.

Webber, D. (1998, April 3). "EP blames forest fires in Indonesia on development projects", World Wide Website: http://earthsystems.org/list/recycle/0696.html. (1998, April 21).

Weinstock, J.A. (1985). "Borneo- Rattan: A complement to swidden agriculture". *Ecodevelopment News* 34, 7-8.

____. (1983). "Rattan: Ecological balance in a Borneo rainforest swidden". *Economic Botany* 37(1), 58-68.

Wilkinson, C.J.A. (1998). *The Liberation of the Wild: Perspectives on Biological Conservation and North American Grey Wolves*. York University. Unpublished MES thesis.

World Bank Group. (1998). "Key Events of the Indonesian Crisis". World Wide Website: http://www.worldbank.org/html/extdr/offrep/eap/invents.htm. (1998, July 28).

World Bank Group. (1994). "Indonesia: Environment and Development". World Wide Website: http://www.worldbank.org/html/extdr/offrep/eap/toc.htm. (1995, December 6).

World Conservation Monitoring Centre. (1998). "1992 Protected Areas of the World: A review of national systems". World Wide Website: http://www.wcms.org.uk/cgi-bin/pa_paisquery.p. (1998, July 21).

World Wildlife Fund. (1998). "Global Annual Forest Report 97". World Wide Website: http://www.panda.org/forests4life/report97/ (1998, July 21).

Van Klinken, G. (1997, November 29). "Pesticides out of control in Kalimantan". World Wide Website: http://www.serve.com/inside/digest/dig45.htm (1998, November 23).

van Valkenburg, J.L.C.H. (1997). "Rattan: Species composition, abundance, distribution, and growth". In van Valkenburg, J.L.C.H. *Non-Timber Forest Products of East Kalimantan: Potentials for Sustainable Use.* pp. 97-127. The Netherlands: The Tropenbos Foundation.

Vandermeer, J. and Perfecto, I. (1995). *Breakfast of Biodiversity: The Truth about Rain Forest Destruction.* Oakland: The Institute for Food and Development Policy.

Von Koenigswald, R. (1982). "Distribution and evolution of the orangutan, Pongo pygmaeus". In de Boer, H.M. (ed.) *The Orang Utan: Its Biology and Conservation*, pp. 1-15. The Hague: Dr. W. Junk Publishing.

Yeager, C.P. (1997). "Orangutan rehabilitation in Tanjung Puting National Park, Indonesia", *Conservation Biology* 11(3), 802-805.

Zimmer, C. (1995). "Tooling through the trees", *Discover* 16(11), 46-48.

Appendix 1

Rattan Species of Sungai Wain Forest

Species	Type	Height	Habitat	Distribution
Calamus blumei	Cluster	20m	Variety < 800m	Widespread but not abundant
Calamus caesius	Cluster	< 100m	Lowlands to 800m	Widespread
Calamus fimbriatus	Cluster	< 10m	Slopes primary/logged over forest	Borneo (Wanariset)
Calamus flabellatus	Cluster	30m	Lowland dipterocarp forest < 500m	Local
Calamus javensis	Cluster	> 10m	Most major forest types < 2000m	Common throughout Borneo
Calamus laevigatus laevigatus	Solitary	> 30m	Variety of soils to 900m	Throughout Borneo
Calamus laevigatus mucronatus	Solitary	> 60m	Usually ridge tops or poor soils	Widespread but not abundant
Calamus marginatus	Solitary	> 15m	Sea-level to 1800m	Common throughout Borneo
Calamus nigricans	Cluster	< 20m		Borneo (Wanariset)
Calamus ornatus	Cluster	> 50m	Primary dipterocarp forest/better lowlands	Widespread throughout Borneo
Calamus pananosmus	Cluster	< 15m	Lowland dipterocarp forest	Rare
Calamus pilosellus	Cluster	< 10m	Summit? > 300m	Local
Calamus pogonacanthus	Cluster	< 30m	Low-uplands/river bank/disturbed sites	Widespread throughout Borneo
Calamus praetermissus	Cluster	< 25m	Lowland dipterocarp forest < 500m	Common
Calamus sarawakensis	Cluster	< 30m	Lowland dipterocarp forest and kerangas	Abundant
Ceratolobus concolor	Cluster	< 15m	Gentle slopes, dipterocarp forest < 600m	Scattered throughout Borneo
Daemonorops didyomophylla	Cluster	< 15m	Lower hillsides and valleys < 1000m	Widespread throughout Borneo
Daemonorops elongata	Cluster	< 4m	Lowland dipterocarp forest/hillsides	Endemic throughout Borneo
Daemonorops fissa	Cluster	< 30m	Lowlands, especially secondary forest	Widespread throughout Borneo
Daemonorops hystrix	Cluster	< 10m		
Daemonorops korthalsii	Cluster	< 15m	Lowland	Widespread throughout Borneo
Daemonorops periacantha	Cluster	< 10m	Lowland and hill dipterocarp forest	Widespread throughout Borneo
Daemonorops sabut	Cluster	< 40m	Valley bottom/hill slopes < 800m	Widespread
Korthalsi furtadoana	Cluster	> 20m	Lowland forest	Abundant in Sabah
Korthalsia echinometra	Cluster	< 40m	Lowland and hill and dipterocarp forest	Widespread
Korthalsia ferox	Cluster	High	Hill dipterocarp forest < 700m	Widespread throughout Borneo
Korthalsia flagellaris	Cluster	> 40m	Confined to peat swamp forest	Throughout Borneo
Korthalsia rigida	Cluster	< 50m	Lowland and hill dipterocarp forest < 900m	Widespread throughout Borneo
Plectomiopsis geminiflora	Cluster	< 30m	Disturbed sites in hill dipterocarp forest	Common throughout Borneo
Plectomiopsis mira		< 40m	Lowland and hill dipterocarp forest	Scattered throughout Borneo