ECOLOGICAL SURVEY OF THE IMPENETRABLE (BWINDI) FOREST, UGANDA, AND RECOMMENDATIONS FOR ITS CONSERVATION AND MANAGEMENT

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SUMMARY

1. UGANDA CONTINUES TO WITNESS THE RAPID LOSS AND DETERIORATION OF ITS NATURAL RESOURCE BASE (FORESTS, WILDLIFE, FISHERIES, GRAZING, SOIL AND WATER) AND, THEREFORE, ITS OPTIONS AND CHANCES FOR LONG-TERM, SUSTAINABLE ECONOMIC DEVELOPMENT. At present, the Nation is in a situation in which its people are compelled to destroy those very natural resources which are necessary to relieve them of hunger, disease and poverty . . . those same resources required for successful national development. To escape this dilemma, Uganda must do far more to conserve and rehabilitate its natural resources and, most importantly, to integrate conservation with development.

2. SUCCESSFUL, SUSTAINABLE ECONOMIC DEVELOPMENT CANNOT BE ATTAINED IF ECOLOGICAL GUIDELINES AND CONSIDERATIONS ARE IGNORED. Recognizing this fact, Uganda is currently formulating its National Conservation Strategy, the proposed goals of which are to:

   a. ensure the sustainable use of Uganda's natural resources;

   b. preserve the genetic diversity of Uganda;

   c. maintain essential ecological processes;

   d. use natural resources to satisfy the material, spiritual and cultural needs of all the people of Uganda, both present and future generations.

3. TROPICAL MOIST FOREST CONSERVATION. The tropical moist forest is the oldest and biologically most complex, richest, and least understood biome on earth. While covering only 6 percent of the world's land surface, the tropical moist forest houses 50 to 65 percent of its five to ten million species of plants and animals. Yet the tropical moist forest is being destroyed and disrupted by human activities more rapidly than any other biome. Much that is irreplaceable is disappearing every hour, and mankind is only beginning to realize and experience the long-term detrimental impact of these losses.

   One of the most urgent and important challenges during the next decade is to reverse this reckless and irresponsible trend. There can be no doubt that should we fail, all of mankind will suffer.

The impact will be greatest, however, in the Lesser Developed Countries within whose borders the tropical moist forest is found . . . one of these countries is Uganda.

Prior to felling by man, tropical moist forest probably covered more than 6 percent of Uganda's land surface. Today, under a rapidly expanding human population, these forests have been reduced by at least 50 percent, and the destruction continues at an unprecedented rate.

There can be no doubt that the tropical moist forest has a major role to play in the sustained economic development of Uganda. Unfortunately, however, nearly all of Uganda's remaining tropical moist forest occurs in forest reserves, and these are constantly threatened with intense, and often unplanned and illegal, human exploitation. Such exploitation is extremely serious as it diminishes the Nation's resource base and, hence, its opportunities for development.

4. THE IMPENETRABLE FOREST. From the standpoint of its conservation values, and its present and potential economic, cultural and spiritual contributions to the people, the Impenetrable (Bwindi) Forest (321 km^2) stands as one of the premier tropical moist forests in Africa.

5. THIS REPORT IS CONCERNED WITH THE LONG-TERM CONSERVATION AND MANAGEMENT OF THE IMPENETRABLE FOREST. Specifically, this report:

   a. assesses the conservation values of the Impenetrable;

   b. describes and evaluates management/conservation problems in the Impenetrable;

   c. explores the importance of conserving the Impenetrable as an integral part of Uganda's strategy for conservation-based development;

   d. makes recommendations to help ensure that the Impenetrable is conserved and that its present and future contributions to the people of Uganda are not diminished.

6. LOCATION AND STATUS OF THE IMPENETRABLE FOREST. The Impenetrable lies in Kabale and Rukungiri Districts of south-western Uganda. At this time it is both a Central Forest Reserve and an Animal Sanctuary.

7. <u>BIOTIC AND ECONOMIC VALUES OF THE IMPENETRABLE FOREST:</u>

a. The dense vegetative cover of the Impenetrable prevents soil erosion on its steep mountain slopes and, thus, also protects water courses and lakes from siltation.

b. The Impenetrable is an important water catchment and the source of several major rivers flowing to Lakes Edward, Mutanda and Bunyoni, and the drier agricultural areas to the north and west.

c. The Impenetrable is, by far, the largest tract of natural forest in south-western Uganda. It, therefore, represents the last opportunity to conserve a sample of the vegetation which once covered nearly all of Kabale and Rukungiri Districts.

d. The Impenetrable is the only forest in East Africa, and one of the few in Africa, where contiguous forest vegetation extends from 1,160 to 2,600 metres a.s.l. As a result of this altitudinal range, the species diversity of the Impenetrable is exceptionally high. It is one of the richest forests in Africa in terms of plant and animal species, and harbors a number of rare and endangered species not found elsewhere in East Africa. It is thus an important evolutionary factory and storehouse of genetic wealth--a potential source of new foods, fibers and drugs, as well as knowledge.

e. The mountain gorilla is in danger of extinction. Mountain gorillas occur only in the Virunga Volcanoes area of Rwanda, Zaire and Uganda, and in the Impenetrable Forest. The population in the Impenetrable is reported to have dropped from approximately 150 animals in 1959 to 115 in 1979. At present, the world's population of mountain gorillas numbers fewer than 400 individuals, with the Impenetrable providing habitat for about one-third of these.

f. Nine other species of non-human primates occur in the Impenetrable. These include the chimpanzee which is listed as "vulnerable to extinction" in IUCN's Red Data Book. Elephant, giant forest hog, bushpig, bushbuck and several species of duiker are also present.

g. The Impenetrable offers a number of unique and interesting attractions for tourists. Besides the mountain gorilla and other large mammals, these include exceptional mountain scenery, rich array of montane and lowland forest flora and fauna, and a comfortable climate. The Impenetrable has the potential for becoming a major tourist attraction, and thus a source of local income and foreign exchange.

8. <u>THE CURRENT SITUATION IN THE IMPENETRABLE FOREST.</u> Some of the more serious conservation/management problems in the Impenetrable are as follows:

   a. Illegal prospecting and mining for gold are rampant and causing considerable damage to the vegetation and watershed.

   b. Large amounts of fuelwood, timber, bamboo and poles are being removed illegally. In 1982/83 about 80 percent of the timber trees cut were felled illegally.

   c. Poaching is common and widespread. Buffalo, and possibly leopard, have become extinct. Elephant, giant forest hog and bushbuck are on the verge of extinction.

   d. There is a high level of human activity. Between 512 and 1049 people enter the Impenetrable each day, and the number is increasing. Probably no part of this forest is free from disturbance by humans.

   e. About 45 percent of the people in the Impenetrable are conducting illegal acts there. Approximately 90 percent of their exploitive activities are illegal, including the removal of wood, bamboo, livestock forage, minerals, honey and meat.

   f. Exploitation is not conducted under a scientifically sound policy. There are no recent data by which to determine if or how the Impenetrable should be exploited.

9. <u>RECOMMENDATIONS FOR IMPROVED CONSERVATION/MANAGEMENT OF THE IMPENETRABLE FOREST:</u>

   a. <u>The entire Impenetrable Forest should be designated a national park.</u> This is the most important recommendation and one which was first put forth in 1971 by National Parks "to ensure for future generations that in the National Parks system is represented as wide a spectrum as possible of the flora, fauna, and areas of great scenic beauty of the Nation." Unfortunately, this proposal was never acted upon.

An "Impenetrable Forest National Park" would ensure that this forest:
- remains in a natural state;
- continues to benefit the people;
- contributes to development of the Nation.

An Impenetrable Forest National Park would help achieve sustained economic development in Uganda as well as the other proposed goals of the National Conservation Strategy.

b. Five additional areas should be gazetted to the Impenetrable Forest. The five areas total only 30 km^2. They will, however, greatly enhance the conservation values of the Impenetrable and are critical for its long-term protection.

c. A permanent research station should be established and an intense program of applied research undertaken on the ecosystem, flora and fauna of the Impenetrable Forest. There are presently few data available on this forest. This is a major impediment to rational decision making, and thus to the development of a sound management policy. A permanent research station is needed to initiate, integrate, coordinate and support an active program of applied research. The research station must:
   - assist in the establishment of a management/conservation policy for the Impenetrable and in incorporating this policy into Uganda's National Conservation Strategy;
   - train people capable of effective research, conservation and management;
   - answer critical management/conservation questions, especially as applies to the mountain gorilla;
   - secure moneys for research and education, and for the implementation of management/conservation practices.

d. Other recommendations include:
   - revision of The Forests Act, The Game Act, and Working Plan;
   - bring more senior Forest Department and Game Department staff to the Impenetrable, increase staff numbers, and improve supervision and coordination of activities;
   - increase Forest Department and Game Department support equipment and salaries;
   - stop all illegal activities, particularly illegal mining, hunting and pit-sawing;
   - halt all exploitation until the situation can be brought under control and managed scientifically;
   - build no new roads and close the Buhoma-Ivi River Road.

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"Natural resources are the engine of development; conversely, development is dependent on the continued productivity of the natural resource base. The paradox that emerges is that development is dependent on the very resources it threatens with extinction. Unless management strategies are developed that combine use with conservation, improvements in living standards and national wealth are jeopardized."
(Endangered Resources for Development, 1984)

1. BACKGROUND AND PERSPECTIVE

1.1 INTRODUCTION

Throughout this report the word "conservation" is used to mean the sustained rational utilization of resources based on ecological principles. "Development" connotes activities designed to make wise use of natural resources. The partnership between conservation and sustainable development stipulates that plans for development must include ecological criteria, principles and guidelines in all phases of regional economic development (Dasmann, Milton & Freeman, 1973). If ecological considerations are ignored, the economic development of regional populations cannot be sustained.

"Conservation, like development, is for people; while development aims to achieve human goals largely through use of the biosphere, conservation aims to achieve them by ensuring that such use can continue. The integration of conservation and development is particularly important, because, unless patterns of development that also conserve living resources are widely adopted, it will become impossible to meet the needs of today without foreclosing the achievement of tomorrow's."
(World Conservation Strategy, 1980)

Of paramount concern at this time is the establishment and maintenance of this critical link between conservation and development in the Less Developed Countries (LDCs), particularly those LDCs with tropical moist forests (TMFs) (World Conservation Strategy, 1980). One of these countries is Uganda.

Until about fifty years ago, human activities in the TMFs of Uganda were confined primarily to shifting agriculture, hunting of animals, harvesting of food and medicinal plants, and small-scale logging and mining. Uganda's human population was relatively small, and its demands on the TMFs were minimal. Today Uganda has the fourth densest human population in tropical Africa. Most of its TMFs have been destroyed through cultivation. There is intensive human pressure to remove, through unplanned and uncontrolled exploitation, what little natural forest remains.

This report is concerned specifically with an outstandingly important area of TMF in south-western Uganda called the Impenetrable (Bwindi) Forest. In what follows, I (1) describe the management and conservation problems currently facing the Impenetrable Forest, (2) assess the conservation values of the Impenetrable Forest, (3) explore the importance of conserving the Impenetrable Forest as an integral part of Uganda's strategy for development and conservation, and (4) make recommendations as to how the Impenetrable Forest can best contribute to the long-term benefit of the people of Uganda.

1.2 THE TROPICAL MOIST FOREST--WHAT IS BEING LOST!

1.2.1 THE GLOBAL SITUATION

TMFs represent the oldest (50 million years) and biologically most complex, richest and least understood biome on earth (Ahmad, 1979; Allen, 1975; Myers, 1979; Richards, 1973). While covering only 6 percent of the world's land surface, they house at least two-thirds of its five to ten million species of plants and animals (Lewin, 1983). Yet, TMFs are being more rapidly destroyed and disrupted by human activities than any other biome. The world's TMFs are falling far faster than nature can replace them. Much that is irreplaceable is disappearing every hour, and mankind is only beginning to realize and experience the long-term detrimental impact of these losses (Poore, 1976, Myers, 1979, 1980; Oldfield, 1981) (Appendix A).

Between 1978 and the year 2,000, the LDCs will fell 40 percent of their remaining TMFs. A minimum of 40 ha of TMF are lost each minute. At this rate, we are losing 2.2 percent of the remaining TMF each year. . . and the rate continues to accelerate. Many authorities predict that, if current attitudes and practices persist, few parts of this biome will elude severe damage by the end of this century (Allen, 1975; Gomez-Pompa et al., 1972; Meijer, 1980; Myers, 1976, 1980; Sommer, 1976). The TMFs of the world may all but vanish in eighty-five years (Righter, 1983).

Hand-in-hand with the destruction of TMFs and the loss of the benefits that TMFs provide (Appendix A) is the loss of species and subspecies of plants and animals. About one thousand animals and twenty thousand flowering plants are presently threatened with extinction (Myers, 1976). We could lose one million species of plants and animals before the year 2,000 . . . 10 to 20 percent of the earth's total (Global 2000; Myers, 1979; Lovejoy, 1978). Most of these species will be lost because of the removal of TMFs.

> "For the first time in geologic history, a major extinction episode will be entrained by a global overshoot of carrying capacity by a single species--Homo sapiens. Human populations, in other words, are growing so explosively and are modifying the environment so extensively that other species are perishing in the wake of it all: no other single species has inflicted such an inimical global impact . . . in the poorer countries the race for agricultural development is the principal threat to many species, but this includes the extensive felling of tropical moist forests, which has the single most extensive potential impact on future species diversity." (Lewin, 1983)

> ". . . the loss of natural forest means much more than an economic loss of wood. It means the transformation, damage, or loss of whole environmental

systems, the disappearance of plant and wildlife species, the destruction of watersheds, the onset of erosion, the possible change of whole water regimes in valleys and lowlands. Management of forests is not simply about wood production, but about the state of health and productivity of the environment as a whole, including adjacent and even distant agricultural and urban areas."

(Lanly and Clement, 1979)

1.2.2 THE SITUATION IN UGANDA

Prior to felling by man, TMFs probably covered more than 6 percent (11,800 km^2) of Uganda's land surface.[1] Today the TMFs of Uganda have been reduced by at least 50 percent and probably considerably more. The loss of TMF in Uganda continues at a high rate. In 1964, Uganda had about 6,500 km^2 of TMF (Langdale-Brown, et al., 1964; Osmaston, 1966). By 1981 the TMF had been reduced to 5,500 km^2 (FAO and UNEP, 1981). This represents a 15 percent reduction in just seventeen years. Uganda's present cover of TMF is expected to be reduced by 25 percent before the end of this century (FAO and UNEP, 1981). Thus, unless the current trend is broken, Uganda will have less than 4,000 km^2 of TMF by the year 2,000.

Most of the loss of TMF in Uganda during the last two decades has been due to illegal encroachment by agriculturalists (FAO and UNEP, 1981; Van Orsdol, 1983a,b; Butynski, pers. observ.). This problem continues to be the primary threat facing the TMFs of Uganda.

1.2.3 COMMENT

One of mankind's greatest, most urgent and most important challenges during the next decade is to reverse this irrational and irresponsible trend. Our goal should be to conserve and manage the TMF biome so as to minimize man's adverse impact and achieve maximum sustained benefits

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[1] Today the geographical limit of Uganda's TMFs conforms fairly closely to the 114 cm (45") isohyet for rainfall (Langdale-Brown et al., 1964). It is a conservative estimate, therefore, that TMFs in Uganda occurred in all areas where the annual rainfall is more than 127 cm (50"). Six percent of Uganda gets more than 127 cm of rain each year (Hamilton, 1982). Thus, there are at least 11,800 km^2 of potentially suitable area for TMF in Uganda.

(Appendix A). There can be no doubt that should we fail, all of mankind will suffer. The impact will be greatest, however, in those LDCs within whose borders TMFs are now found.

1.3 NATURAL RESOURCES IN UGANDA

1.3.1 GENERAL

During much of this century Uganda experienced considerable development and prosperity. Prior to the 1970's Uganda had one of the highest per capita incomes in Africa, a well-developed infrastructure, and a sound economy. This period ended during the 1970's as the country came under military rule and, in 1979, witnessed a War of Liberation. During the last five years, Uganda has made considerable progress in its attempts to recover from the disasters of the 1970's (see Proposal for a National Conservation Strategy for Uganda, 1983).

1.3.2 HUMAN POPULATION AND AVAILABILITY OF NATURAL RESOURCES

Uganda's human population is now growing at an annual rate of about 3 percent (FAO, 1982). The number of people increased more than two-and-a-half-fold between 1948 (5.0 million) and 1980 (12.6 million). It is expected to increase two-and-a-quarter-fold between 1980 and the year 2,000 (28.6 million) (Sakman, 1979). At the present rate of growth, there will be a nineteen-fold increase in Uganda's population during the next century.

This rate of growth is having an acute negative effect on the resources available to each Ugandan. For example, in 1948 there were 3.6 ha of arable land per person, there are now only 1.4 ha per person, and at the turn of the century there will be fewer than 0.6 ha per person . . . and the land will probably be far less productive.

Because of the high human population and its great dependence on agriculture, Uganda is now experiencing a shortage of land, trees and other resources. Whereas, historically, Uganda has been self-sufficient in food and wood products, and has frequently been an exporter, it is now an importer.

"There is no room for miracles. Land is finite. No science offers infinite entries to solve the

world's food problem. What science can provide is time to solve the population problem."
(Ponnamperuma, 1983)

1.3.3 FORESTRY

Approximately 45 percent of the land area of Uganda is considered forested (FAO, 1980). This is highly misleading, however, as only about 5 percent (10,000 km^2) of the land is covered by permanent productive forest, while 40 percent harbors savannah woodland (FAO, 1980; Forest Dept. Report, 1983). The savannah woodland is largely on public land and is used primarily for fuelwood, poles and is extensively grazed. Very little TMF (natural high forest) remains on public land and what does remain is being rapidly destroyed.

The gazetted reserved forest estate (under the control and administration of Forest Department) is about 16,000 km^2, or 8 percent of Uganda's land surface. Of this, 6,410 km^2 (40 percent) is listed as TMF, 210 km^2 is eucalyptus and softwood plantations, and the balance is savannah woodland (9,080 km^2, 57 percent) or open grassland and bare rock (300 km^2, 2 percent) (FAO, 1980; FAO, 1982).

FAO estimates that 66 percent of Uganda's forest cover was lost between 1961 and 1972. The Ministry of Agriculture and Forestry has assessed this loss at an even higher percentage (Proposal for a National Conservation Strategy for Uganda, 1983). In 1979 it was estimated that 12 percent of the TMF had been lost to illegal encroachment by agriculturalists (FAO, 1979). This encroachment continues (Van Orsdol, 1983a,b; Butynski, pers. observ; Proposal for a National Conservation Strategy for Uganda, 1983; Forest Dept. Report, 1983). It is, thus, likely that less than 5,000 km^2 of TMF remain in Uganda today.

"Management of the tropical high forest is of deep concern. The Budongo, Kibale and the Mabira Forests and other scattered remnants are some of the last remaining high forest examples in eastern Africa, not only producing high quality woods, but providing habitat for wildlife as well. However, these complex and fragile stands are under siege by fire, encroachment by agriculture, high grading and general lack of attention." (FAO, 1982)

Uganda is facing a fuelwood shortage. In 1974 it was estimated that Uganda had to plant an additional 210 km^2 into plantations (a 233 percent increase) to meet its fuelwood needs for the year 2,000 (Lockwood Consultants, 1974). Additional areas had to be planted to provide poles and lumber. This has not been done.

Many people now point to the few remaining TMFs as sources of relief against wood and land shortages. As detailed in Appendix A, the inherent benefits of the TMF are too great to allow them to be heavily exploited for wood or cleared for agriculture. Such action would only be of limited, short-term benefit, short-sighted and, most important, only postpone and make worse a problem which Uganda must soon face in any case. The destruction of Uganda's remnant TMFs will not solve its current problems . . . the only solutions are population control, better forest protection and management, reafforestation of felled areas, and establishment of plantations on a massive scale.

1.3.4 TOURISM AND WILDLIFE

During the early seventies the tourist industry, based primarily on wildlife, was the second largest income producer in Uganda (FAO, 1982). Management and protection of national parks and wildlife were severely disrupted during the years of military rule, large numbers of wildlife were destroyed and the tourist industry collapsed.

The killing of large numbers of animals continues today as the result of poaching and, more importantly, through the destruction of habitat by illegal encroachers. Uganda is losing an important part of its national heritage, a major tourist attraction, and considerable potential for earning foreign exchange.

> "It should be remembered that the volume of international tourism which could develop when the existing hotel capacity has been restored to its former standard has a potential yield of 30 to 35 million U.S. dollars of foreign exchange annually, counting only the tourist who use commercial accommodations. From a tourist point of view, national parks and wildlife are a self-marketing natural resource, and in Uganda it was a very profitable one. The aim now is to recapture this trade." (FAO, 1982)

More and more people are developing an interest in visiting TMFs (Gartlan, 1974; Budowski, 1981a). The addition of TMFs to the tourist circuit in Uganda would undoubtedly serve as a major attraction for many of today's visitors and provide a powerful impetus for the lasting protection of Uganda's TMFs (Appendix A).

1.4 STRATEGIES FOR CONSERVATION AND DEVELOPMENT

1.4.1 THE WORLD CONSERVATION STRATEGY: LIVING RESOURCE CONSERVATION FOR SUSTAINABLE DEVELOPMENT

The World Conservation Strategy (1980) requests all nations to adopt ecologically sound development policies, to participate in international efforts to improve the human environment and to protect the biosphere.

> "It shows that over exploitation of resources, loss of genetic diversity and damage to ecological processes and life-support systems are dangerously reducing the planet's capacity to support people in developed and developing countries. It seeks a new partnership between conservation and development, to meet human needs now without jeopardising the future." (Africa Link, 1983)

The primary goals of the World Conservation Strategy are:

1. The maintenance of essential ecological processes and life support systems.
2. The preservation of genetic diversity through the conservation of animal and plant species.
3. The sustainable use of species and ecosystems to ensure that all our resources are used carefully with due consideration of the needs of future generations.

1.4.2 UGANDA'S NATIONAL CONSERVATION STRATEGY

Each country must establish its own National Conservation Strategy if the World Conservation Strategy is to succeed. All nations should develop their own conservation action plans based on the general goals, principles and guidelines of the World Conservation Strategy. Each National Conservation Strategy should be tailored towards achieving sustainable development while maintaining life support systems and encouraging the optimum use of natural resources.

The Proposal for a National Conservation Strategy for Uganda (1983) puts forth the following objectives for Uganda's National Conservation Strategy:

1. Ensure the sustainable use of Uganda's natural resources. (Forests, fisheries, wildlife, agricultural and grazing land.)

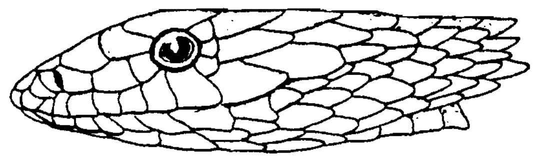
2. <u>Preserve the genetic diversity of Uganda</u>. (The range of genetic material governing the scope of yields and quality of crops and livestock, as well as the rich diversity of wild species and their habitats.)

3. <u>Maintain essential ecological processes</u>. (Soil protection, nutrient recycling, protection of waters.)

4. <u>Use natural resources to satisfy the material, spiritual and cultural needs of all the people of Uganda, both present and future generations</u>.

According to the Proposal for a National Conservation Strategy for Uganda (1983), the priorities to be attended to in order to achieve conservation objectives in Uganda are:

1. Obtain knowledge of the productive capacities of natural resources.
2. Ensure that use of natural resources does not exceed the sustainable level.
3. Increase the efficiency of resource use.
4. Adopt conservation management objectives.
5. Revise development plans according to resource availability.
6. Protect representative ecosystems.
7. Implement protected area management plans and monitoring systems.
8. Improve the genetic base of crop and livestock species.
9. Identify the worst erosion/desertification areas.
10. Implement soil conservation measures.
11. Implement watershed protection measures.
12. Control environmental pollution.
13. Start conservation education programs.
14. Redefine extension programs.
15. Plan the growth of populations.
16. Provide people with equal opportunities to enjoy the benefits of natural resources.
17. Respect traditional ways of life.



"All the forest values of Africa are threatened with extinction; the ecosystems that provide them are receding because of degradation or conversion to less stable forms.

Managing ecosystems so that they yield their benefits in perpetuity means conserving them."

(D. U. U. Okali, 1982)

2. GENERAL INFORMATION ON THE IMPENETRABLE FOREST

2.1 LOCATION

The Impenetrable Forest is located in south-west Uganda (latitude 0°53'S to 1°8'S; longitude 29°35'E to 29°50'E) (Figure 1). This reserve, situated on the edge of the Western Rift Valley, occupies the highest block of the Rukiga Highlands. It lies on the Zaire border about 29 km north-west of Kabale, 18 km north of Kisoro, and 40 km south-east of Lake Edward. The Impenetrable is situated in Rubanda and Bufumbira Counties of Kabale District, and in Kinkizi County of Rukungiri District.

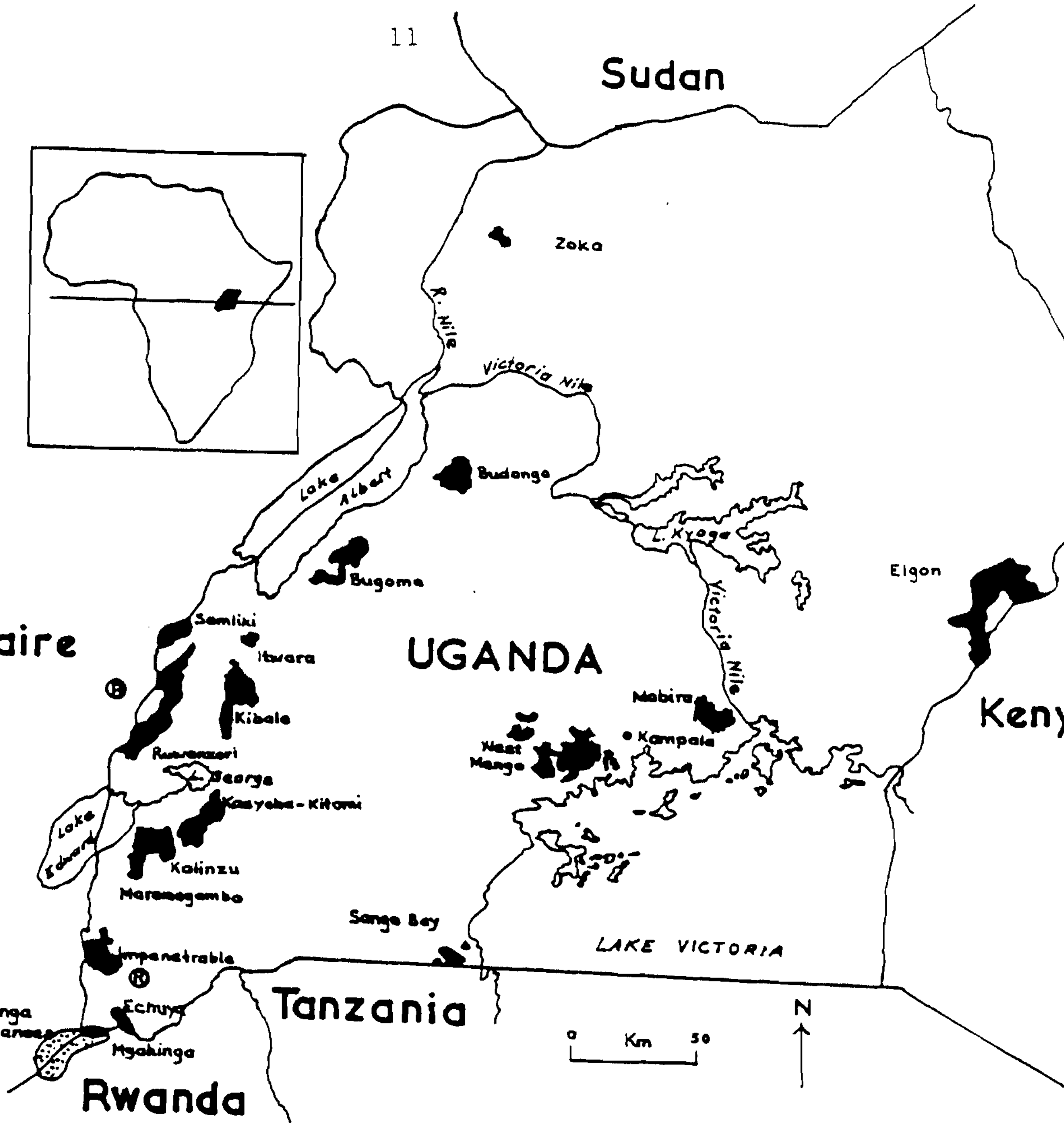


Figure 1. Location of the Impenetrable Central Forest Reserve and other blocks of natural forest in Uganda (from Atlas of Uganda, 1967, and Hamilton, 1982). "R" designates the location of two hypothetical Pleistocene forest refuges (after Hamilton, 1975, 1976). The Impenetrable Forest and Virunga Volcanoes are the only two sites in the world where mountain gorillas are found.

2.2 NAME CHANGES

Considerable confusion has been caused by the fact that the Impenetrable Forest (and various portions of it) has been referred to by different names. This forest has been called the "Kayonza" (Pitman, 1935; Emlen & Schaller, 1959; Stott, 1960; Schaller, 1963; Kingdon, 1971; Haltenorth & Diller, 1980), "Impenetrable-Kayonza" (Williams, 1967; Hamilton, 1974, 1975, 1976), "Impenetrable" (Leggat & Osmaston, 1961; Friedman & Williams, 1968, 1970; Keith, 1968, 1980; Keith & Twomey, 1968; Keith et al., 1969; Struhsaker, 1981a), "Bwindi-Kayonza" (Kingdon, 1973; Hamilton, 1981), and "Bwindi" (Harcourt, 1981).

These many name changes are unfortunate as they have created unnecessary difficulties and misunderstandings among government officials, resource managers, scientists and tourists. I suggest that the most acceptable solution is to refer to the entire forest as the "Impenetrable." There are several reasons for making this proposal:

1. This forest was gazetted the "Impenetrable Central Forest Reserve" in 1948 (Leggat & Osmaston, 1961; Forests Act, 1964) and "Impenetrable Forest Animal Sanctuary" in 1961. As far as I can determine, no official government change of these names has occurred.

2. The vast majority of governmental and scientific publications concerned with this Reserve refer to it as the "Impenetrable." These include many of the maps and Forest Department's Working Plan and Boundary Plan.

3. "Impenetrable" is a word which aptly describes this forest. It is a word which is easy to remember and which provides connotations of a place of great interest, if not excitement and adventure. This later point is likely to be of considerable importance in promoting tourism and in securing financial support for the conservation, management, and development of this Reserve.

2.3 NORTH SECTOR AND SOUTH SECTOR

The Kitahurira-Kayonza Road passes through the Impenetrable Forest near Kitahurira where the Reserve is but 1 km wide. The large blocks of forest to the north and south of this road differ considerably in flora, fauna and elevation. It is convenient and useful, therefore, to refer (as do Leggat and Osmaston, 1961) to the forest below 1,500 m and to the north of this road as the "North Sector," and to the area above 1,500 m and to the south of this road as the "South Sector" (Figure 2).

2.4 PHYSICAL FEATURES AND CLIMATE

2.4.1 GEOLOGY

The Impenetrable Forest lies at the north-west end of the Rukiga Highlands. These Highlands are associated with upwarping of the Western Rift Valley and are underlain by Precambrian shale, phyllite, quartz, quartzite, schist and granite of the Karagwe-Ankolean System (Combe and Simmons, 1933; Leggat and Osmaston, 1961).

2.4.2 SOIL

The soils of the Impenetrable Forest are derived primarily from Precambrian phyllite of the Karagwe-Ankolean System. The Atlas of Uganda (1967) classifies the soils of the Impenetrable as being of two types; "non-differentiated humic ferrallitic soils of high altitudes" and "non-differentiated ferrallitic soils with dark horizons." In general, the soils are tropical red earths overlain with spongy humus. Clays occur under a layer of peat in the swampy valley bottoms (Leggat and Osmaston, 1961).

Harrop (1960) recognized two soil series for the Impenetrable. The "Mafuga Series" covers upland sites and consists of latosols and loams. The upper 0.5 to 1.2 m of this series is usually acid, stoneless, and weakly structured or structureless.

The "Ntendule Series" consists of poorly structured clay loams and silt clay loams. These soils are even more acid than those of the Mafuga Series (pH as low as 2.9) and are extremely deficient in bases. In fact, the lowest pH ever encountered in montane soils by Chenery (1951), during much fieldwork in the tropics, was noted in the Impenetrable.

In summary, the soils in the Impenetrable Forest are of poor structure, of moderate to high acidity (pH 2.9 to 5.2) and very deficient in bases (see Appendix F in Leggat and Osmaston, 1961). This renders them low in productivity. Because these soils become very loose and friable as they dry, they are highly susceptible to erosion, especially once the forest vegetation is removed and cultivation is undertaken. Agriculture must, therefore, be considered a poor land-use option for this area.

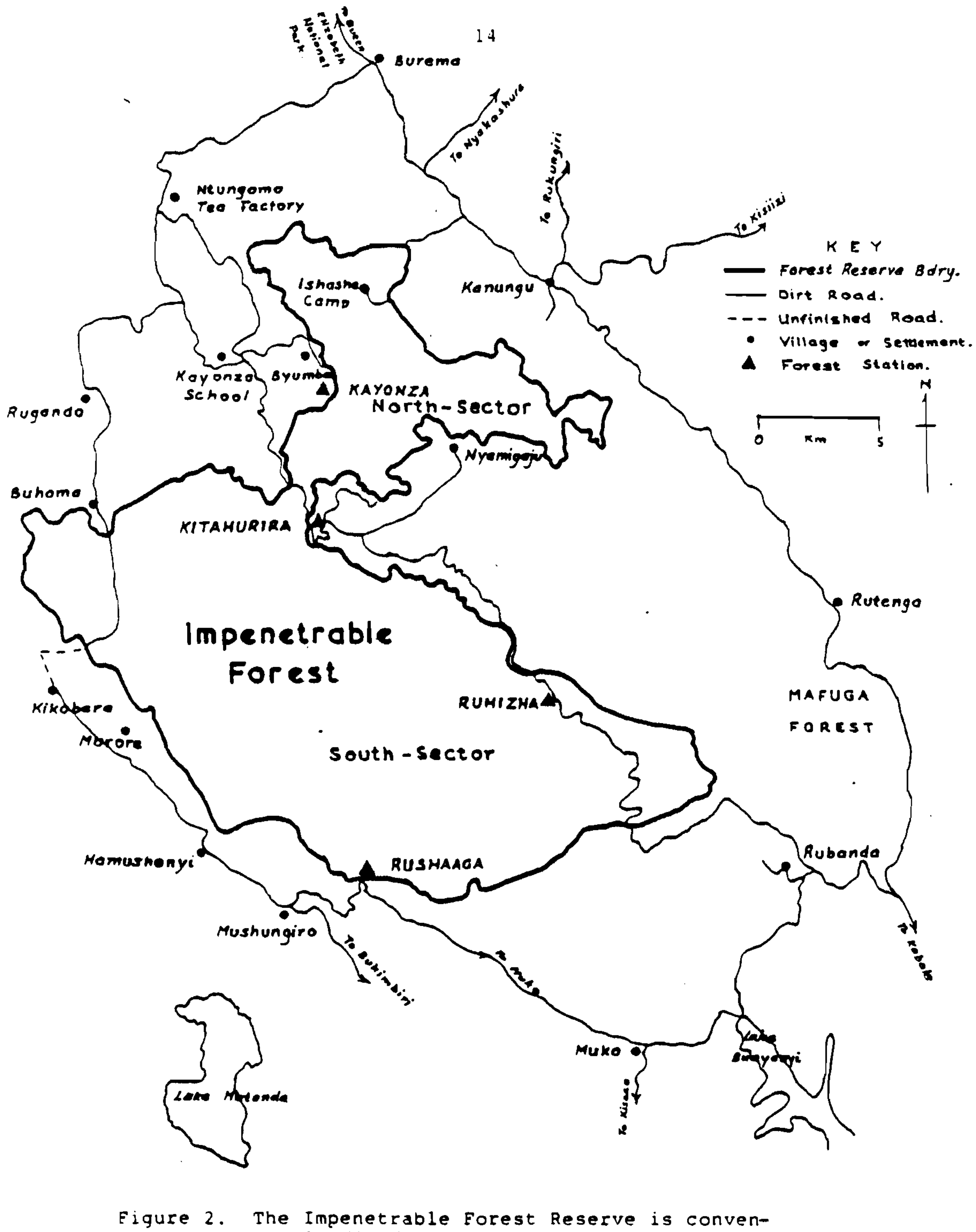


Figure 2. The Impenetrable Forest Reserve is conveniently divided into a "North Sector" and a "South Sector" demarcated by the road which runs through the narrow neck of the Reserve at Kitahurira. Locations of forest stations and roads in and around the Impenetrable are shown. The four stretches of road entering the Impenetrable provide for a high level of human activity, both legal and illegal.

2.4.3 TOPOGRAPHY

The topography of the Reserve is extremely rugged and much dissected, especially in the higher South Sector. The only flat area of any size is Mubwindi Swamp (c. 1 km2). The remainder consists of narrow, very steepsided valleys which run in all directions and are bounded by hill crests lying between 1,400 m in the North Sector and 2,600 m in the South Sector. The highest hills in the Reserve (Rwamanyanyi 2,607 m, Nyaigulu 2,510 m, Rusho 2,457 m, Kasatora 2,423 m) lie near the south and south-east boundaries of the South Sector. From here the elevation gradually descends to 1,160 m at the northern-most point in the North Sector (Figure 3).

2.4.4 DRAINAGE

The Impenetrable is an important water catchment area (Figure 4). It gives rise to several major rivers which flow to the drier country to the north and west of the Reserve, and to the densely populated agricultural areas to the south. About four-fifths of the drainage is to Lake Edward via the Ivi, Munyaga, Ntengyere, Ihihizo and Ishasha Rivers. The remainder is into Lake Mutanda via the Shongi River, and into Kigeyo Swamp and Lake Bunyonyi via the Ndego River. The Impenetrable is thus a primary source of water for Lakes Edward, Mutanda and Bunyonyi.

In a study of East African forest hydrology, McCullock and Dagg (1965) found that only when annual rainfall was above 130 cm did a significant surplus of water accrue resulting in permanently flowing water sources. They indicated that such forested areas represented critical catchment areas for virtually all of Africa's perennially flowing water courses. Less than 5,500 km^2 of Uganda is now covered with forest which receives more than 130 cm annual precipitation. In other words, less than 3 percent of the land surface constitutes Uganda's critical catchment area. Thus, at 321 km^2, the Impenetrable Forest represents approximately 6 percent of Uganda's "true water catchment surface."

Water conservation and catchment protection are perhaps the most obvious and vital reasons for protecting the Impenetrable Forest (Appendix A). This was recognized by Leggat and Osmaston (1961) and given special mention in the first Working Plan for this Reserve, "The objects of management are: (a) to preserve the forest cover in the optimum state necessary to sustain stream flow, prevent soil erosion and maintain favorable climatic conditions; . . ."

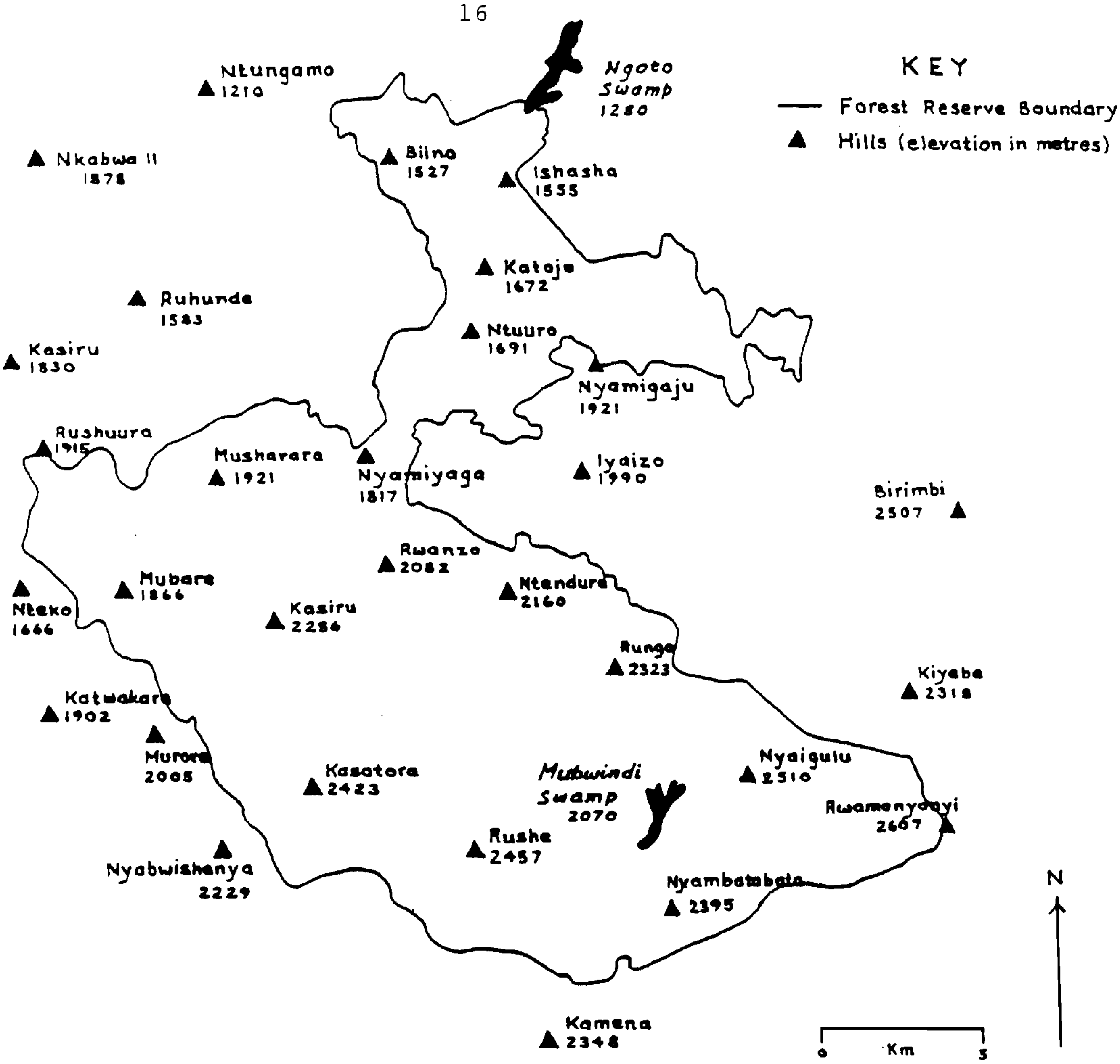


Figure 3. Locations and elevations of the highest hills in various parts of the Impenetrable Forest Reserve. Also shown are the two largest swamps in the area, Mubwindi Swamp and Ngoto Swamp. Note that there is a gradient from the highest point in the south-east corner of the Reserve (Rwamanyonyi Hill, 2607 m) north-westwards to the lowest point at the extreme north end of the forest (1,160 m). This considerable elevational gradient strongly influences the distributional pattern of many plants and animals in the Impenetrable and accounts for much of the great species-richness of this forest.

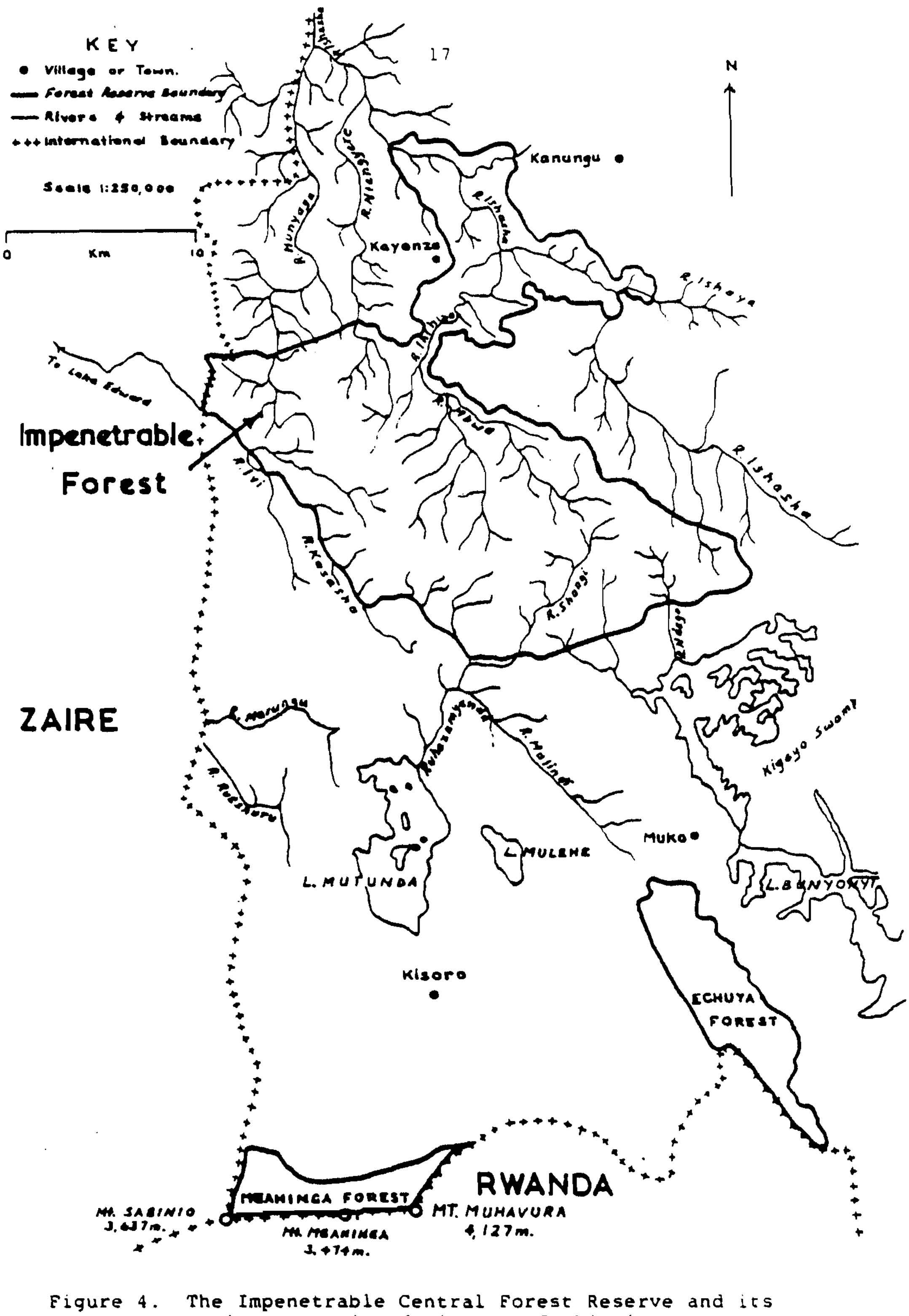


Figure 4. The Impenetrable Central Forest Reserve and its environs. Major drainages of this important watershed are shown. Note that rivers originating in the Impenetrable Forest flow north to Lake Edward and south to Lake Mutanda and Lake Bunyoni.

2.4.5 CLIMATE

The prevailing winds over the Impenetrable Forest, especially during the dry seasons, are from the south-east (Leggat & Osmaston, 1961).

Temperature data are not available for the Impenetrable. However, based on the temperature at Kabale for forty-two years (Statistical Abstract, 1974), and using "the normal East African temperature/altitude relationship, which gives a lapse rate of 1.98°C for every thousand feet" (J. A. Channon, pers. comm. in Hamilton, 1969), we expect the mean annual temperature at Ruhizha(2,300 m in the South Sector, Figure 2) to be about 13°C with a mean daily minima of 7°C and maxima of 20°C. The lowest temperatures must be approximately 0°C. The coolest period is June - July but mean monthly temperature probably varies by less than 4°C through the year.

The twenty-one year (1963 - 1983) mean annual rainfall at Ruhizha (Figure 2) is 144 cm. Annual rainfall during this period ranged from 113 cm to 239 cm. A "rainy day" is one on which 1 mm or more of rain is recorded. Number of rainy days per year varies from 122 to 177, with a mean of 148.

There are two dry seasons, December - January and June - August, the latter being the longer and more severe (Figure 5). The two wettest periods are March - April and September - November.

Cool air accumulates in the valleys at night. This air generally becomes saturated with water vapor, forming heavy mists which are common during the mornings and after rains. Leggat and Osmaston (1961) suggest that "Owing to the size of the forest, it may have an important stabilizing effect climatically, especially by its influence on the number of rainy days which occur."

2.5 LEGAL STATUS

2.5.1 FOREST RESERVE

According to Leggatt and Osmaston (1961), this forest was originally gazetted in 1932 as Kasatoro Crown Forest (South Sector today)(181 km^2) and Kayonza Crown Forest (North Sector today) (26 km^2). In 1942 the Kasatoro Crown Forest and Kayonza Crown Forest were combined and additional forest was added to establish the Impenetrable Crown Forest (324 km^2). About 26 km^2 were deleted from the Reserve in 1948, and it was

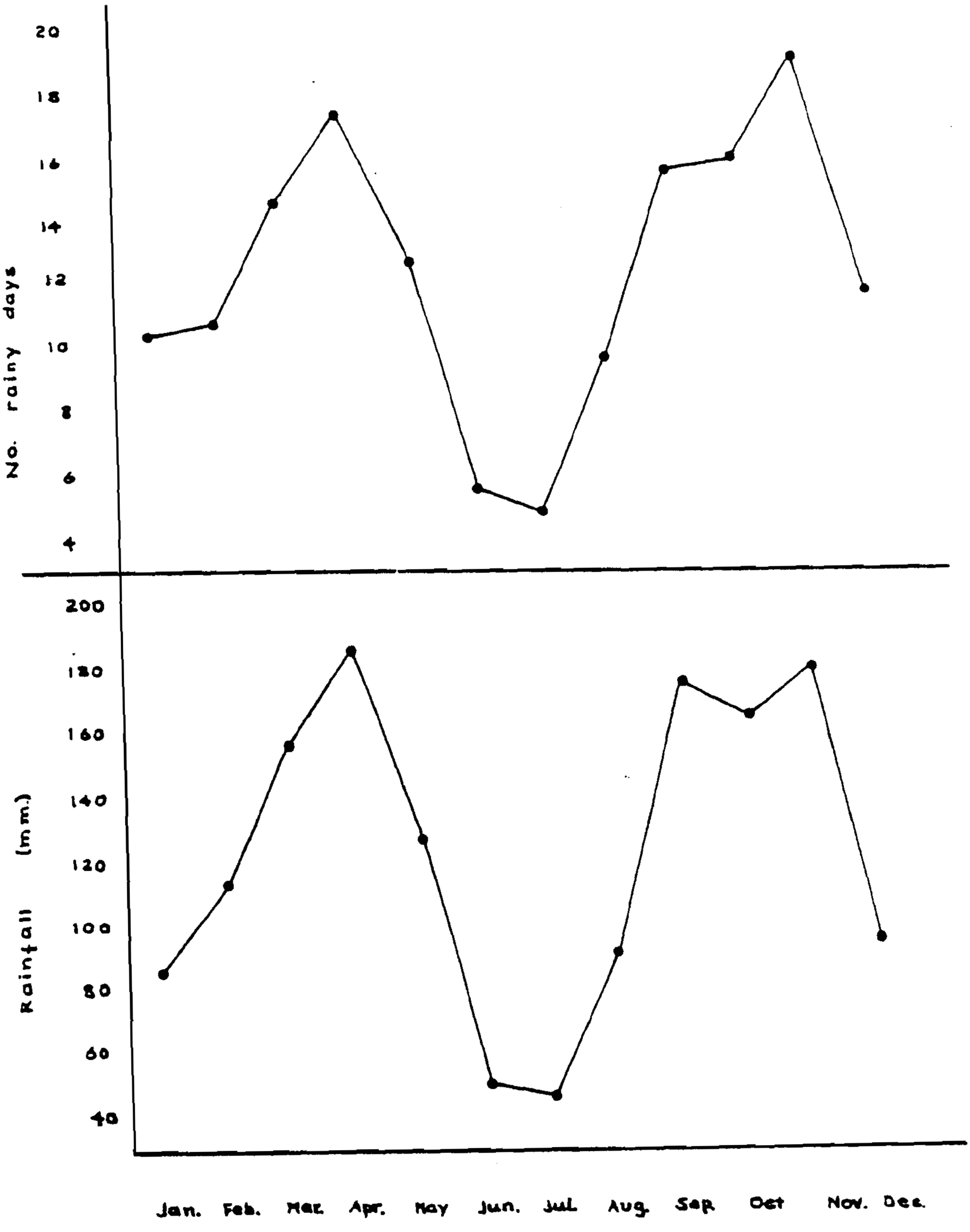


Figure 5. Monthly mean total rainfall and monthly mean total rainy days at Ruhizha Forest Station, Impenetrable Forest, Uganda (1963-1983). Data provided by the Uganda Meteorological Department.

regazetted the Impenetrable Central Forest Reserve (298 km^2). These gazettings were consolidated in the Laws of Uganda in 1951. Additional small excisions were made in 1958 in order to shorten the boundaries and make them easier to maintain and patrol.

As of 1961 two Local Forest Reserves bordered on the Impenetrable; the Bikingi Local Forest Reserve (7.6 km^2) off the center of the south boundary of the South Sector, and the Ishaya Local Forest Reserve (13.8 km^2) off the center of the east boundary of the North Sector. In 1966 these two Local Forest Reserves were incorporated into the Impenetrable Central Forest Reserve. At this time the Impenetrable Central Forest Reserve is 320.8 km^2 (123.9 mi^2).

2.5.2 NATURE RESERVES

The original management plan for the Impenetrable Central Forest Reserve (Leggat & Osmaston, 1961) called for the establishment of two nature reserves. One nature reserve is presently being designated in each of the two sectors. These two nature reserves are described in Appendix B (see Butynski, 1984).

2.5.3 ANIMAL SANCTUARY

The Impenetrable Forest was gazetted as an Animal Sanctuary in 1961 with boundaries the same as those of the Impenetrable Central Forest Reserve.

2.6 GOVERNMENT STAFF ASSIGNED TO THE IMPENETRABLE FOREST

FOREST DEPARTMENT STAFF

As of February, 1984, Forest Department staff directly responsible for the Impenetrable Central Forest Reserve consisted of 45 people. These were as follows:

2 District Forest Officers

2 Foresters

4 Forest Rangers

2 Forest Officers

8 Forest Guards

27 Forest Workers and Patrolmen

GAME DEPARTMENT STAFF

As of February, 1984, Game Department staff directly responsible for the Impenetrable Forest Animal Sanctuary was comprised of seven people. These were as follows:

1 Game Warden

5 Game Guards

1 Vermin Guard

2.7 HUMAN POPULATION NEAR THE IMPENETRABLE FOREST

2.7.1 POPULATION DENSITY

In 1980 there were approximately 352,000 people living in the three counties in which the Impenetrable Forest is located (Bufumibira, Rubanda and Kinkizi Counties). This is a population density of about 140 people per km^2 (Report on the 1980 Population Census, 1982).

Between 1948 and 1980 the human population in Kabale and Rukungiri Districts increased 90 percent from 396,000 to 752,000 (Statistical Abstract, 1974; Report on the 1980 Population Census, 1982). The annual rate of population increase in Kabale and Rukungiri Districts between 1969 and 1980 was 1.2 percent and 1.9 percent, respectively (Report on the 1980 Population Census, 1982). This area has one of the highest population densities in Africa, and emigration to less crowded areas is at a high level. As long ago as 1965 one-third of the male work force was looking for work elsewhere (Myers, 1971).

2.7.2 ETHNIC GROUPS

There are two primary ethnic groups living in Bufumbira, Rubanda and Kinkizi Counties. About 90 percent of the people are Bakiga, while most of the remainder are Banyarwanda (Atlas of Uganda, 1967). Batwa Pygmies probably account for far less than 0.5 percent of the population.

2.7.3 THE BATWA

The Batwa Pygmies of south-western Uganda were, until recently, hunter-gatherers in the TMF of that region. With increasing numbers of Bakiga, the area covered by TMF has been greatly reduced during the last century (Lind, 1956; Purseglove, 1950). This loss of TMF, coupled with close relationships with the Bakiga, has had a considerable influence on Batwa culture. As with other forest people, "the most destructive impact of development is loss of land. Without land, they cannot support themselves, and a once self-sufficient people ceases to be so."(Poore, 1976).

There is little information available on the Batwa of south-western Uganda. For this reason, and because there is a close association between many of the remaining Batwa and the Impenetrable Forest, I will present some general information on the Batwa living near the Impenetrable. This information is taken from the notes of Mr. Jonathan Kingdon. They were gathered during his visit to the Impenetrable Forest in June, 1984.

1. Batwa are distributed around the edges of the Impenetrable Forest, with major concentrations at Buhoma and Rubuguli. Some also live at Kitahurira and Mashoho. Probably no Batwa live within the Reserve boundaries.

2. There are about thirty to fifty Batwa families associated with the Impenetrable. Average family size is near seven. The number of children ranges from one to ten. The total number of Batwa here is likely not in excess of three hundred.

3. While formal marriage alliances between the Batwa and the Bakiga are almost unheard of, there are clandestine associations which are blurring genetic distinctions more and more.

4. Many Batwa retain a semi-feudal dependence on specific Bakiga patrons but most are relatively independent.

5. The present Batwa community consists of hunters, guides, gold diggers, pit-sawyers, porters, builders, farmers, craftsmen and gatherers of forest produce, particularly honey. The Batwa are being absorbed into the dominant Bakiga culture.

6. The Batwa are generally recognized as being the source of virtually all knowledge about the forest. They have achieved an intimate and valuable knowledge of the Impenetrable Forest and the natural products it contains. This knowledge has considerable scientific and economic potential (Oldfield, 1981).

Because of their strong cultural and economic ties with the TMF, the Batwa should be given particular consideration and integrated, where practicable and desirable, into future management/development plans for the Impenetrable and its environs.

2.7.4 LAND USE

The destruction of forest outside the boundaries of the Impenetrable Forest is nearly complete (Section 3.4.1). The landscape has become a patchwork of small agricultural plots, terraces and family compounds. Now that the forested land is virtually gone, there is heavy human pressure on the swamps. Most swamps have been partially drained and the areas used for growing crops or grazing livestock.

Principal crops grown in this region are sweet and Irish potatoes, bananas, sorghum, beans and soybeans. Cattle, goats, sheep and chickens are the most important domestic animals.

2.8 ECOLOGICAL SURVEY OF THE IMPENETRABLE FOREST

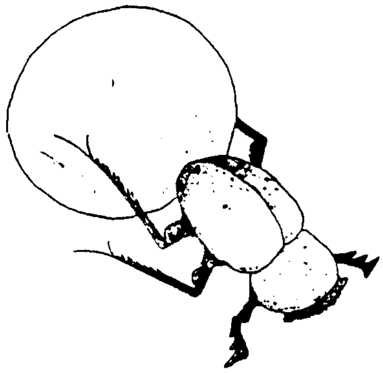
The field work upon which this report is based was conducted during seven trips to the Impenetrable Forest from February, 1983 to August, 1984, inclusive. A total of about sixty days were spent in the Impenetrable Forest on this survey.

The primary aims of this survey were to:

1. determine the status of the flora and fauna, particularly the larger mammals;

2. assess the kinds of human activities and the impact of each on the flora and fauna;

3. gauge the importance of the Impenetrable Forest in providing for the present and future needs of the people of Uganda, particularly the regional population.



"The vicious circle by which poverty causes ecological degradation, which in turn leads to more poverty, can be broken only by development. But if it is not to be self-defeating, it must be development that is sustainable--and conservation helps to make it so. The development efforts of many developing countries are being slowed or compromised by lack of conservation.

. . . there is a close relationship between failure to achieve the objectives of conservation and failure to achieve the social and economic objectives of development--or, having achieved them, to sustain that achievement."

(World Conservation Strategy, 1980)

3. HUMAN ACTIVITIES IN THE IMPENETRABLE FOREST

3.1 RULES GOVERNING THE REMOVAL OF FOREST PRODUCE AND WILDLIFE

3.1.1 THE WORKING PLAN

Leggat and Osmaston (1961) put forth a working plan for the Impenetrable Central Forest Reserve for the period of July 1, 1961 to June 30, 1971. This working plan was approved by the Chief Conservator of Forests in 1961. Although provision was made for a new working plan to be submitted by January 1, 1970, this was never done. The Working Plan states that "No deviations from the prescriptions of this plan may be made without the approval of the Chief Conservator of Forests."

The following is a partial list of the guidelines and regulations for human activities in the Impenetrable Forest as stated in the Working Plan. These guidelines and regulations were selected for presentation here because they are of particular concern to the findings and recommendations of this report, and thus to the protection and conservation of the Impenetrable.

1. The number of licensed pit-sawyers is to be restricted to a maximum of 100.

2. Three coupes are to be established, and these divided into compartments of 80 to 160 ha. All trees in these compartments are available for felling (i.e., there is no minimum girth limit). The exception is Podocarpus for which a girth in excess of 10 ft. (3.04 m) at 10 ft. above ground is required before felling. Only one compartment in each of the three coupes is to be harvested at a time. Harvesting is to be allowed until a total of 100,000 ft^3 (2,830 m^3) per year are cut from all three coupes combined. The District Forest Officer is to authorize entry into a new compartment for felling only when all specimens of the eight Reserved Species with a girth greater than 5 ft. (1.52 m) at 10 ft. above ground have been removed. The Reserved Species are:

Chrysophyllum spp	Maesopsis eminii
Entandrophragma spp	Newtonia buchanani
Fagara macrophylla	Podocarpus spp
Ficalhoa laurifolia	Symphonia globulifera

(Pygeum africanum was added to this original list of eight species in 1964.)

3. Except in the Nature Reserves, felling of all dead and dying trees, regardless of size, and over-mature trees with a 10 ft. minimum girth at 10 ft. above ground is allowed without limit. The only exceptions are Entandrophragma and Newtonia for which the minimum girth is 12 ft. (3.65 m) at 10 ft. above ground.

4. Any felling damage must be repaired by the Forest Guard at the time of measuring felled trees.

5. In order to detect illegal felling, sawyers must stamp all boards with their registered letter/number dies.

6. Rangers must keep close check on timber volume cut in each coupe.

7. Artificial boundaries must be maintained.

8. Grazing of livestock within the reserve is not allowed.

9. No felling of any kind is allowed in the nature reserves. The nature reserves are to provide gorillas and other representatives of the local flora and fauna with a sanctuary from all effects of harvesting, silviculture and produce removal. The nature reserves will be clearly marked by notices erected on their boundaries.

3.1.2 THE FORESTS ACT (1964)--KIGEZI RULES

The Forests Act (1964) provides a set of rules and privileges by which human utilization and exploitation of the Impenetrable Forest is regulated (The Forests (Kigezi) Rules, Section 31). These regulations are designed to control and monitor the offtake of forest produce, enhance conservation and law enforcement, and yield revenue to government.

The rules and privileges listed below are especially relevant.

1. Any forest produce, except private or reserved trees, may be taken from Kigezi forest land without license or fee by any African in reasonable quantities for his own personal domestic use. Such produce includes timber, poles, bamboo and fuelwood. No produce, however, is to be cut or removed without a permit, and shall not be moved from the place where it was cut or taken until checked and marked by a forest ranger or forest guard.

2. A licensee can only fell trees or collect forest produce if the trees or produce have been marked or otherwise designated for felling or collection by a forest ranger or forest guard.

3. Within seven days of felling trees or collecting the produce, the licensee must notify a forest ranger or forest guard of the felling or collection so that the forest ranger or forest guard can measure the trees or produce.

4. The licensee must not commence to saw up or convert any trees, or remove from the place of felling or collection any tree or produce, until he has been authorized to do so by a license to take forest produce. Timber or boards must be marked with the sawyer's registered letter dies before they are moved from the place they were cut or from a storage place prescribed on the license.

5. Each sawyer licensed to cut timber on Kigezi forest land must register a set of letter dies with the Forest Superintendent. Letter dies must be re-registered annually. Each piece of timber cut by a sawyer must be marked with his letter dies.

6. The licensee must take all necessary precautions to prevent damage to other forest produce while operating under license. The licensee is responsible for the acts of his employees.

7. The licensee and his employees must at all times assist the Forest Department employees in the prevention and extinction of fires, and in the prevention and detection of forest offenses.

8. It is illegal to reside, cultivate or graze livestock in a central forest reserve without a permit from Forest Department.

3.1.3 THE GAME ACT (1964)--GAME RESERVES AND SANCTUARIES

The Game (Preservation and Control) Act (1964) puts several restrictions on the use of game reserves and sanctuaries by people. Some of these are as follows:

1. No person shall reside in any game reserve, or cultivate land or depasture or water any domestic animal in any game reserve, without the written authority of the Chief Game Warden.

2. Any person who hunts or captures an animal in a game reserve or who is found within a game reserve in circumstances which show that he is there for the purpose of hunting shall be guilty of an offense unless he is the holder of a special permit.

3.2 PROBLEMS WITH LAW ENFORCEMENT IN THE IMPENETRABLE FOREST

As will be seen in Sections 3.4 through 3.12, many of the people now utilizing the Impenetrable Forest have little respect for The Forests Act, The Game Act, The Mining Act or the prescriptions of The Working Plan. Violations are numerous. While Forest Department has done an excellent job of preventing some types of violation, particularly encroachment, it has not controlled some other activities, especially timber extraction. Game Department, likewise, has been ineffective in curtailing poaching.

Law enforcement in the Impenetrable has been hampered by the following factors:

1. Working relationships between Forest Department and Game Department personnel in the Impenetrable have not always been good. This problem appears to have been solved recently.

2. Much time and effort are wasted because Forest Guards are not authorized to uphold The Game Act, and Game Guards are not permitted to enforce The Forests Act.

3. Supervision by senior staff in both Departments is inadequate. This lowers morale, while encouraging inefficiency and poor work habits.

4. It appears that the primary reason for the lack of law enforcement in the Impenetrable is the low incentive. For example:

a. Inadequate penalties for criminals. Violators, when apprehended, are often not adequately fined or imprisoned. The penalties prescribed by The Forests Act and The Game Act are completely inappropriate as they no longer serve as a deterrent to law breakers. The maximum penalty for most violations of The Forests Act (1964) is six months imprisonment and/or a fine of 2,000 U. Shs. The maximum penalty under the Game Act (1964) for killing an elephant is two years imprisonment and/or 4,000 U. Shs.

Violators are seldom captured and even less often imprisoned. Thus, a person who illegally cuts a tree whose lumber is valued at 50,000 U. Shs., or kills an elephant whose ivory and meat are worth 500,000 U. Shs., finds little deterrent to his crimes. Until the penalties imposed by The Forests Act, The Game Act and Mining Act are brought in line with the income generated by illegal activities, the laws will be neither respected nor enforceable. Forest Department and Game Department field personnel have been frustrated by this situation for many years now.

b. The salaries of all Forest Department and Game Department staff are too low. This greatly limits the incentive to do a good job and forces people to subsidize their salary with other sources of income.

c. Support equipment is lacking. These range from uniforms and vehicles, to construction materials and weapons. A proper job cannot be done without the right equipment.

3.3 METHOD FOR ASSESSING HUMAN ACTIVITY

In this analysis, I divided the Reserve into 323 one kilometer square "blocks" (Table 1). All blocks entered and searched for more than 0.5 km were considered to have been surveyed. Each block was designated as being in the "interior of the forest" or "fringe of the forest," depending on whether it lay within 1.4 km of any road or boundary. This methodology is similar to that used by Harcourt (1981).

During this survey a total of 124 one kilometer square blocks were examined (Table 2). In addition, thirty-seven blocks were surveyed outside the Reserve. Twelve more blocks were surveyed in June, 1984, but the data collected from these does not appear in the detailed analysis which follows (Figure 6).

3.4 REMOVAL OF WOOD PRODUCE FROM THE IMPENETRABLE FOREST

3.4.1 LOSS OF NATURAL FOREST ON ADJACENT PUBLIC LAND

In 1954 approximately 120 km^2 of natural forest remained on those public lands lying within 15 km of the borders of the Impenetrable Forest. This did not include public lands in Zaire. The above estimate was obtained by the "dot grid overlay method" using Map Sheets 84/3, 84/4, 93/1 and 93/2, all of the East Africa 1:50,000 Series Y732.

Table 1. The number of 1 km^2 blocks located at various distances from the nearest boundary or road in the North and South Sectors of the Impenetrable Forest, Uganda (1983/84).

Distance	North Sector		South Sector		Total	
	No.	%	No.	%	No.	%
$<$1.4 km	39	61	76	29	115	36
1.4$\rightarrow$2.8 km	23	36	74	29	97	30
$>$2.8 km	2	3	109	42	111	34
Total	64	100	259	100	323	100

Table 2. The locations of 1 km^2 blocks surveyed and their use for various human activities. Data for the Impenetrable Forest, Uganda (1983/84).

Location of 1 km2 blocks. Distance from nearest road or boundary	No. of blocks surveyed	Pit-sawing		Illegal stumps		Hunting		Mining		Livestock		Footpaths		Overall*	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
$<$1.4 km	62	18	29	9	15	17	27	1	2	8	13	59	95	58	94
1.4$\rightarrow$2.8 km	30	8	27	6	20	6	20	2	7	1	3	18	60	22	73
$>$2.8 km	32	10	31	8	25	7	22	4	12	3	9	6	19	24	75
Total	124	36	29	23	19	30	24	7	6	12	10	83	67	104	84

* Some sign of human use seen

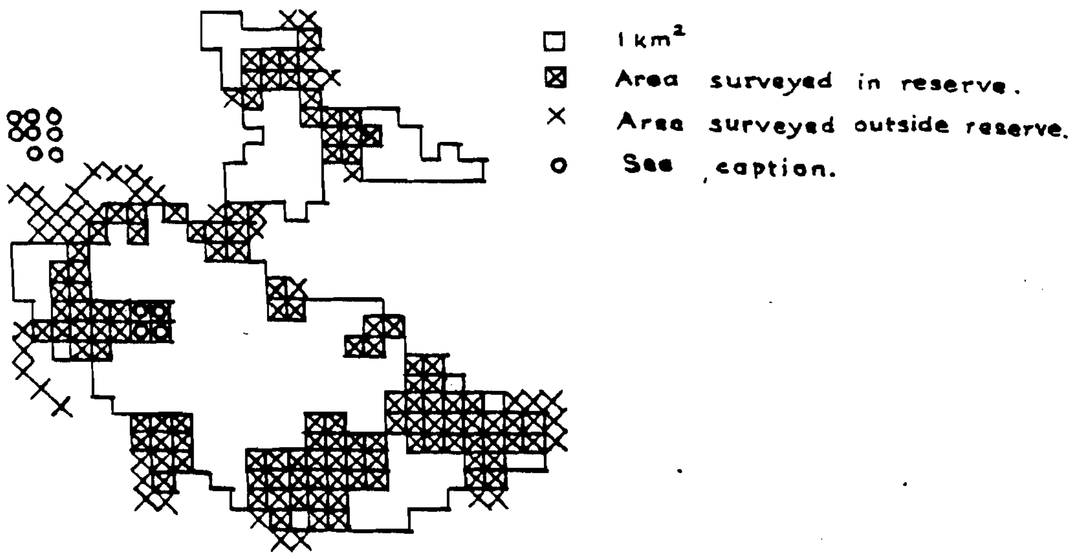


Figure 6. Schematic map of the Impenetrable Forest Reserve indicating areas entered and searched during this survey. Approximately 38% of this 321 km^2 Reserve was surveyed. In addition, about 37 km^2 outside of the Reserve were investigated. Circles indicate places surveyed during June, 1984. This was after most of this report was completed. Thus, most of the data collected during June, 1984, does not appear in this report.

By 1972 this 120 km^2 area of natural forest was reduced by about 42 km^2 (35 percent). This value was obtained by the "dot grid overlay method" using a Landsat photo (8" x 10" color subscene of Orbit 186, Frame 061 of September 13, 1972).

Based upon my 1983/84 survey, I estimate that there are presently fewer than 20 km^2 of natural forest on public land lying within 15 km of the borders of the Impenetrable. Thus, this area of natural forest has been reduced by more than 83 percent in thirty years. At this rate of loss there will be virtually no natural forest on these public lands by 1990. This loss of natural forest is having detrimental effects both on the people of the region and on the conservation values of the Impenetrable Forest.

3.4.2 FIREWOOD AND POLES

The boundary of the Impenetrable Forest runs for approximately 115 km. About 97 percent of this boundary is adjacent to agricultural settlement. The only place where the Impenetrable is contiguous with a sizable tract of forest is along its 3 km border with Zaire.

Having removed most of the trees from their lands, the local people are entering the Reserve along most of its periphery to obtain poles and fuelwood. None of these people have permits from Forest Department to remove poles or fuelwood (Section 3.1.2). Ample quantities of poles and fuelwood appear to be available from areas outside of the Reserve, but poles and fuelwood from these sources are apparently not so easily or cheaply obtained. I saw no effort by Forest Department to prevent or regulate the removal of these materials from the Reserve.

As a result of these activities, the peripheral 1 km of the Reserve has received the heaviest human use and now exhibits the greatest amount of damage to vegetation and wildlife (Sections 4.3.2 and 4.3.3). Much of the vegetation along the periphery must now be classified as secondary forest as the undergrowth is often dense, the large valuable trees have been pit-sawn, and the straight saplings cut for poles. This degradation will undoubtedly continue to increase and expand unless Government takes steps to control these activities.

3.4.3 BAMBOO

An area of mountain bamboo (Arundinaria alpina) less than 0.4 km^2 in size occurs near 2,400 m in the south-east corner of the South Sector of the Impenetrable Forest (Cahusac, 1958). Only two other stands of bamboo remain in Kabale District, the one in Echuya Forest Reserve 15 km to the south and the one in Mgahinga Forest Reserve 30 km to the south south-west.

The stand of bamboo in the Impenetrable covers only about 1/500th of the area of the Reserve. It is, however, extremely important ecologically. A number of plants and animals obviously prefer the bamboo and are probably restricted to this vegetation type. Should the bamboo be degraded or destroyed, a number of other members of the flora and fauna might also be reduced in number, if not eliminated, within the Impenetrable.

The bamboo zone has a unique avifauna and likely supports the highest densities of elephants, blue monkeys, and lhoesti monkeys in the Reserve. These factors, plus the inherent beauty of bamboo, make this small piece of forest a very important part of the Reserve in terms of animal distribution and tourism. Furthermore, the single most important food plant for gorillas in the Parc National des Volcans in Rwanda is bamboo (Weber and Vedder, 1983). Here ". . . the bamboo zone provides up to 90 percent of the preferred gorilla diet during five months of the year."(Weber, 1981). Although gorillas apparently do not forage in the bamboo in the Impenetrable at present, they probably did in the past. That gorillas no longer use this area is likely due to the high degree of human disturbance here.

The road from Rubanda to Kitahurira, the main road through the Reserve, runs through the bamboo zone. No part of the bamboo zone is more than c. 400 m from this road. About two large lorries travel this road each day. Between twenty and sixty people walk this road daily, while many others travel the numerous foot-paths through the bamboo. These people often talk loudly and are sometimes accompanied by dogs and livestock. Voices can be heard for distances greater than 0.5 km into the forest, while lorries can be heard more than 5 km into the forest. The result of the road and these paths is that there is a tremendous amount of human disturbance in the bamboo zone.

Although it is legal to remove bamboo from the Reserve under permit, no such permits were in effect in 1983. Nonetheless, considerable bamboo was openly cut and removed via the road. I observed people cutting bamboo and stacking it in piles along the road. They apparently had little fear that their activities would be stopped by Forest Department. Since my observations, the Forest Department has taken action to reduce the theft of bamboo from the Impenetrable.

It is important to study the effects of harvesting on the fauna and flora of this vegetation type. Furthermore, it must be determined what harvest intensity is compatible with bamboo regeneration and wildlife conservation.

3.4.4 PIT-SAWING

3.4.4.1 DISTRIBUTION OF PIT-SAWING ACTIVITY

The human activity most prevalent in the Impenetrable is pit-sawing. It is also the activity which, more than any other, is altering the structure and composition of the vegetation of the Reserve.

A 1 km^2 block was said to contain pit-sawing activity if stumps estimated to be less than five years old were found. My sample indicates that pit-sawing activities in the Impenetrable during the last five years have been fairly evenly distributed throughout the Reserve (Table 2). Overall, I found stumps in 29 percent of the blocks surveyed. This value for the North Sector (26 percent) was similar to that for the South Sector (30 percent). Twenty-eight percent of the blocks within 2.8 km of the periphery of the Reserve had evidence of pit-sawing activity compared with 31 percent for blocks more than 2.8 km from the periphery. In other words, not only is pit-sawing common and widespread in the Impenetrable, it is also as prevalent in the interior of the Reserve as along its periphery.

3.4.4.2 ILLEGAL PIT-SAWING

An "illegally cut tree" is here defined as one whose stump has not been stamped with numbers or letters. Nineteen percent of the blocks surveyed contained illegally felled trees. Of those blocks in which evidence of pit-sawing activity was found, 64 percent had illegally felled trees. The percentage of blocks with pit-sawing in which illegally felled trees were located increased from 50 percent at 0.0 to 1.4 km from the edge, to 75 percent at 1.4 to 2.8 km from the edge, and to 80 percent in blocks more than 2.8 km into the Reserve (Table 2). These data suggest that Forest Department was less effective in preventing illegal pit-sawing in the interior of the Reserve than near the periphery.

I examined 119 stumps during this survey. Ninety-nine (83 percent) of these were not stamped. Of the ninety-three stumps which I estimated as cut within the last two years, seventy-four (80 percent) bore no stamp. In addition, trees of some species, particularly Podocarpus, were often cut below the minimum girth limit. It is impossible to avoid the conclusion that illegal felling of valuable timber trees has occurred on a large scale in the Impenetrable, with perhaps more than eight or ten trees being taken illegally in recent years (also see Section 3.11.5).

3.4.4.3 HOW MUCH LUMBER IS TAKEN AND WHERE DOES IT GO?

My observations and those of senior Forest Department staff in the Impenetrable indicate that an average of at least 1.5 lorry loads of lumber are removed from the Reserve each day. Each lorry carries approximately 300 boards (300 $ft.^3$, 8.5 m^3). Based on this information, I calculate that about 160,000 pieces of lumber (160,000 $ft.^3$, 4,530 m^3) were taken from the Impenetrable in 1983. This is 60,000 $ft.^3$ more than recommended by the Working Plan. It is also about four-fold more lumber than Forest Department records indicate was paid for and allowed on felling permits (Table 3). It appears that, in 1983, Government lost approximately 600,000 U. Shs. in revenue as a result of this illegal activity. It should be noted that considerable quantities of lumber are used locally and are not removed by lorry . . . this lumber is not considered in the above calculations.

There is a second way by which the people and Government of Uganda are not reaping the full benefits from the lumber taken from the Impenetrable. According to several Forest Department and other officials, an estimated 50 to 90 percent of the lumber is taken illegally across the border to Rwanda. By smuggling the lumber out of Uganda, a 30 percent Inland Tax is avoided. Once in Rwanda, much of the "Uganda lumber" is said to be converted into expensive wood products for export.

3.4.4.4 OTHER ACTIVITIS OF PIT-SAWYERS

Considerable damage is done to the vegetation in the vicinity of pit-sawing sites. Much of this damage is unavoidable as the sawyers require poles for the construction of sawing platforms and shelters. In addition, the felling of large timber trees kill or damage other trees. However, many trees, both at the

Table 3. Licensed pit-sawyers operating in the Impenetrable Forest, revenue earned by Government from pit-sawing fees, and the volume of lumber removed legally during fiscal years 1972 through 1984.*

Year	No. Pit-Sawyer Licenses	Revenue (U. Shs.)	Round Vol. (m^3)
1972	30	--	54
1973	--	--	486
1974	--	--	710
1975	--	--	--
1976	--	--	181
1977	--	20,530	798
1978	--	35,573	2,346
1979	54	81,300	2,412
1980	--	88,174	1,180
1981	73	66,751	906
1982	--	354,849	1,015
1983	73	191,993	1,152
1984	42	527,310**	--

* information provided by Forest Department

** last month of fiscal year (June), not included.

site and along the trails leading to these sites, are needlessly damaged and later die. Much of this damage is caused by sawyers casually hacking at a tree with a machete (panga) either while walking along a trail or sitting in camp. Even small cuts can expose trees to diseases and parasites from which they may eventually die. Such actions contravene the regulation that pit-sawyers "must take all necessary precaution to prevent damage to other forest produce . . ." (Section 3.1.2).

The only reason anyone needs to bring spears and dogs into the Reserve is for poaching. Forest Department has instructed pit-sawyers operating in the Impenetrable not to carry spears or bring dogs into the Reserve, but in 1983 this practice was still common. The disassociation of spears and dogs from pit-sawing activities would greatly reduce the suspicion that pit-sawyers are poaching in the Impenetrable.

3.4.4.5 COMMENTS ON PIT-SAWING

The Working Plan states that a maximum of one hundred pit-sawyers be licensed to operate in the Impenetrable (Section 3.1.1). In 1983 there were seventy-three licensed pit-sawyers operating in the Impenetrable (Table 3). The large volume of timber being removed (Section 3.4.4.3) suggests that the actual number of pit-sawing teams operating in the Impenetrable was more than twice this . . . probably between one hundred forty and two hundred.

According to the Working Plan, sawyers are (1) to cut trees only in compartments located in one of the three coupes (18.5 percent of the Reserve area) and (2) to stamp all boards with their registered letter/number dies. In 1983, as in 1979 (Harcourt, 1981), pit-sawyers were operating throughout the Reserve, including the Nature Reserves. No dies were being registered with Forest Department, and no boards were being stamped by sawyers.

Forest Department claims that it abandoned the "coupe system" in the Impenetrable because it lacked sufficient funds to enumerate new compartments into which sawyers could move. Forest Department discontinued the stamping of boards--a regulation specifically implemented "in order to detect illegal felling" (Leggat and Osmaston, 1961)--because dies were no longer available. The result was that Forest Department became unable to monitor and control pit-sawing activities.

In my view, it would have been far better if Forest Department had permitted cutting in "unenumerated compartments" where pit-sawing could still have been somewhat controlled. The best decision, however, would have been to terminate all pit-sawing in the Reserve until funds and dies were available to properly manage and control this activity.

There can be no doubt that pre-1984 pit-sawing activities in the Impenetrable were not in accordance with the original objectives for which this Reserve was established (Leggat and Osmaston, 1961; Section 3.1.1). However, towards the end of 1983, Forest Department began to take action to (1) reduce the number of licensed pit-sawyers, (2) remove illegal sawyers, and (3) restrict the activities of those who remained. Whereas there were seventy-three licensed sawyers in the Reserve in 1983, there were only about forty-two in 1984 (Table 3). By early 1984 the reduction in illegal felling brought on by these actions was already very apparent, and the situation is now certainly improving.

During 1983 a number of important staff changes were made within Forest Department both in Entebbe and in the Impenetrable Forest. These changes have also done much to bring on the present improvement in forestry activities in the Impenetrable. The current Forest Department staff in Entebbe, Kabale, Rukungiri and the Impenetrable must be commended for their dedication and concern, and for recently establishing a feeling of optimism concerning the future of the Impenetrable Forest.

3.5 BEE-KEEPING AND HONEY HUNTING IN THE IMPENETRABLE FOREST

Beehives are constructed and maintained in the Impenetrable Forest. Honey is also collected from natural hives. On at least three occasions, I found large trees which had been felled and the hives destroyed by honey hunters. Fires set by honey collectors to drive out bees may be responsible for the majority of forest fires in the Reserve (Section 3.9).

Hives were observed in five (4 percent) of the 1 km^2 blocks entered. All hives were located in the eastern one-third of the South Sector, being most common in the vicinity of the bamboo zone above 2,300 m. Here it was possible to see more than twenty hives during a two hour walk. Hives were most prevalent along the periphery of the Reserve, but some were located more than 5 km into the forest.

Hives were placed 1 to 3 m above the ground in the fork of a tree. In most cases considerable damage to the vegetation occurred. Large trees were often felled and used in the construction of the hives. In addition, three to five medium sized trees were usually cut around each hive. This was apparently done to create a small clearing for the hive. In some areas more large trees had been felled by bee-keepers than by pit-sawyers.

There are no regulations in the Forests Act or Game Act concerning the use of Forest Reserves and Game Reserves by bee-keepers or honey hunters; nor does the Working Plan for the Impenetrable provide for this activity. Trees are being felled without permit and forest produce (honey) is being removed without permit from the Reserve. It is clear, therefore, that bee-keeping and honey hunting, as now practiced in the Impenetrable, are both illegal activities.

At this time, Forest Department and Game Department personnel in the Reserve are uncertain as to which Department should be concerned with bee-keeping and honey hunting. Since both activities are directly contravening the Forests Act, it seems that they should fall under the control of Forest Department.

3.6 HUNTING IN THE IMPENETRABLE FOREST

3.6.1 LEGAL STATUS

Under the Game Act, all hunting is forbidden in the Impenetrable Forest Animal Sanctuary (Section 3.1.3). It is also illegal to bring spears, traps, guns, nets or dogs into the Reserve. Hunting was banned throughout Uganda in 1978.

3.6.2 PRESENT EXTENT OF ILLEGAL HUNTING (POACHING)

During this survey people were never observed carrying guns or nets in or near the Reserve, although both were reportedly used by hunters in the Reserve. People with spears and dogs were encountered in 13 percent of the 1 km^2 blocks surveyed. Most of these people were either walking along roads through the forest or actively engaged in pit-sawing and probably had no intention of hunting.

Only twice did I meet people in the Reserve whom I strongly suspected were there to poach. One group consisted of three men and the other of fifteen men. These men could provide no evidence that they were pit-sawyers. They carried spears and knives and were accompanied by dogs. None, however, were in possession of meat or skins.

At present, it seems that relatively little poaching is done by large groups of men using dogs to run down animals or to drive animals into nets. Most of the poaching now appears to be with traps.

A total of eighty-nine traps were located during this survey. Fifty-six traps appeared to have been placed for pig and duiker, three for pig, eleven for duiker, three for monkeys and sixteen for francolin and guinea fowl. Of these, twenty-four traps were old and rotten, two were functional but unset, and sixty-three were set (Table 4). See Appendix C for descriptions and notes on the five types of traps known to be used in the Impenetrable.

Traps were found in 12 percent of the 1 km^2 blocks surveyed. Trapping was more than twice as intense in areas further than 1.4 km into the Reserve than in areas within 1.4 km of the boundary. This probably reflects the higher densities of animals, especially pigs and duikers, available in the interior of the Reserve (Section 4.3.3).

Poaching seems to be at a much lower level in the North Sector than in the South Sector. People with spears and dogs were never seen in the North Sector and but one trap was located there. Traps were found in only 4 percent of those blocks surveyed in the North Sector but in 14 percent of the blocks in the South Sector. There was a ten-fold difference in trap density with 0.04 traps found per block surveyed in the North Sector compared with 0.4 traps per block in the South Sector.

In surveying a block, I seldom searched more than 1 percent of the area for traps. Traps, especially those set for primates and fowl, are extremely difficult to locate. Thus, even in the area searched, many traps must have been overlooked. On the other hand, I often walked trails used by poachers and along which a disproportionate number of traps were probably placed. Considering these points, I estimate that there are five to ten traps/km^2 in the South Sector. Although this is but a rough approximation, it nevertheless indicates that poaching in the Impenetrable is presently at a high level.

Table 4. Numbers found and status of five types of animal traps used by poachers in the Impenetrable Forest, Uganda (1983/84)

Type of trap	Non-functional	Functional*	Set	Total
Triggered leg snare	19	2	35	56
Triggered neck snare	2	0	0	2
Antelope snare	0	0	11	11
Fowl snare	1	0	15	16
Deadfall	2	0	2	4
Total	24	2	63	89

* Functional trap but not set.

3.6.3 EFFECTS OF ILLEGAL HUNTING

It is unfortunate that information on the long-term changes in the distribution and abundance of wildlife in the Impenetrable Forest is so limited. However, the data presented in Section 4.3, and knowledge concerning large mammal species in other parts of western Uganda, permit some strong inferences to be drawn concerning the impact of humans on the larger mammals in the Impenetrable.

Although the Impenetrable covers both a considerable area (321 km^2) and altitudinal range (1,160 - 2,600 m), several of the larger species of mammals are today either extinct (buffalo and possibly leopard) or are not known to occur below 1,800 m (elephant, giant forest hog and bushbuck) (Section 4.3.3). These five species are still present, however, in the Maramagambo Forest (900 - 1050 m asl) of the Queen Elizabeth National Park. The Maramagambo lies only 30 km north north-east of the northern-most part of the Impenetrable (1,050 m). These two forests were probably once connected (Hamilton, 1982). There can be little doubt, therefore, that buffalo, leopard, elephant, giant forest hog and bushbuck not only once occupied that part of the Impenetrable between 1,050 and 1,800 m, but also much of south-west Uganda.

Based upon distributions, densities and habitat requirements of buffalo, leopard, elephant, bushpig and bushbuck in other western Uganda forests, two implications can be drawn for these five species in the Impenetrable: (1) all were once distributed throughout the Reserve, and (2) all are now far below the carrying capacity of the Reserve.

How did this situation arise? Although the human population in south-west Uganda has increased during the past thirty years (Section 1.7.1), and the amount of natural habitat outside the Reserve has been much reduced (Section 3.4.1), the habitat within the Reserve has apparently changed little. At its present size, the Reserve still appears capable of sustaining a population of buffalo and leopard, and larger populations of elephant, bushpig, bushbuck, duiker, guinea fowl and francolin than occur today. It seems that the decline and extinction of wildlife in the Impenetrable is primarily the result of excessive poaching. This conclusion is based upon the following observations:

1. There is presently a high level of poaching in the forest.

2. Poaching in the Impenetrable has probably occurred at a consistently high level for many years. Dr. Junichiro Itani found much poaching in the Reserve in 1960 (pers. comm. in Harcourt, 1981). There is no reason to believe that poachers operated at a reduced level prior to 1960, or between 1960 and the present.

3. Poachers are willing to invest considerable time and effort, while at the same time experience low rates of hunting success, in attempts to capture the few remaining large mammals and fowl from extensive tracts of the Impenetrable. Thus, poachers are not only capable of reducing wildlife populations, they are also capable of eliminating them.

Although the five Game Guards presently stationed in the Impenetrable are helpful and knowledgeable, they are simply not doing all that they can, or are supposed to do, in the way of discouraging poaching. At least one of the Guards was not anxious to point out traps and even less anxious to destroy them. I fully agree with Harcourt (1981) that the behavior of at least some Game Guards "clearly indicated that they did not consider apprehension of poachers as part of their duties." Harcourt (unpubl. report) observed that Game Guards "made no attempt whatsoever to catch any of those [poachers] that we came across."

In conclusion, poaching, rather than habitat disturbance, appears to be responsible for much of the decline of wildlife in the Impenetrable. If poaching continues at its present high level, this decline is expected to continue and additional species, most notably elephant, giant forest hog and bushbuck, are likely to become extinct within the decade.

3.7 PROSPECTING AND MINING IN THE IMPENETRABLE FOREST

People can legally prospect and mine for minerals in the Impenetrable Forest. To prospect legally a person must first obtain a license from the Inspector of Mines. According to the Mining Act (1964), "to prospect" means "to search for minerals and includes such working as is reasonably necessary to enable the prospector to test the mineral bearing qualities of the land." According to the Inspector of Mines in Kabale, this usually means that the prospector need not dig a hole more than 1.2 m deep and 0.6 m square. As of

February, 1984, only one person had a license to prospect in the Impenetrable Forest.

To mine legally in the Reserve a person must obtain a mining title from the Inspector of Mines. No such titles are presently valid for the Impenetrable. In addition, prospectors and miners must obtain permission from the Forest Department to work in the Reserve, cut trees, affect stream flow, etc.

At this time, mining in the Impenetrable is primarily for gold. I located mines in 6 percent of the 1 km^2 blocks surveyed. Mines were six times more common in blocks located further than 2.8 km into the forest than in blocks on the periphery of the forest (12 percent vs. 2 percent) (Table 2). After correcting for differential sampling intensity, I estimate that at least 9 percent of the blocks in the North Sector, 8 percent of the blocks in the South Sector, and 8 percent of the blocks in the entire Reserve contain mines. Virtually all of the mines in the Reserve were located in or near water. Since I seldom followed water courses, many of the blocks surveyed must have had mines which went undetected. Thus, the 8 percent figure is a highly conservative estimate. During his 1979 survey, Harcourt (1981) obtained a similar estimate. He found mining activity in about 10 percent of the blocks.

I encountered miners in the Reserve only once. This was a group of fifteen men carrying spears, knives and shovels near Buhoma.

The largest pit-mine found during this survey is near the head of the Mpororo River on Rusho Hill. The area excavated is about 200 m x 20 m. Within this area all of the soil had been turned over, and many 5 m deep pits remain unfilled. The Forest Department officers accompanying me indicated that the miners are taking gold and wolfram from this mine. In addition to severely damaging the soil and watershed, numerous trees have been cut in the vicinity and a small garden established.

Forest Department considers illegal mining to be the major law enforcement and conservation problem in the Impenetrable Forest. I have been told that miners often work in large groups of up to fifty men, and that they are armed with spears, knives and sometimes guns. These factors, plus the value of the minerals they are extracting, all make it potentially dangerous to attempt to arrest or evict miners from the Reserve. Members of the Forest, Game, Mines and Police Departments are, therefore, hesitant to remove illegal prospectors and miners from the Impenetrable.

3.8 LIVESTOCK IN THE IMPENETRABLE FOREST

The Forests Act, Game Act and Working Plan all state that livestock must not be grazed or watered in Reserves (Section 3.1). The one exception for the Impenetrable is that stock may be watered at the salt-lick near the Shongi River (Leggat and Osmaston, 1961).

I found evidence that livestock, usually cattle, had entered 17 percent of the 1 km^2 blocks surveyed in the North Sector and 8 percent of the blocks in the South Sector. Utilization by livestock of blocks less than 1.4 km from the border of the Reserve (13 percent) was more than twice as great as the utilization of blocks more than 1.4 km into the Reserve (6 percent) (Table 2). Correcting for differential sampling intensity of blocks located at various distances from the boundary, it is estimated that 14 percent of the 1 km^2 blocks in the North Sector, and 8 percent of the blocks in the South Sector are entered by livestock at least once every two weeks. Overall, about 9 percent of the blocks in the Impenetrable are utilized by livestock.

Livestock are herded into the North Sector for the purpose of grazing. They are brought into the South Sector primarily to move them south through the forest. I have been told by several persons that cattle are driven through the South Sector so that they can be moved illegally into Rwanda.

Grazing, trampling, and the burning of the vegetation (to improve grazing conditions) were most prevalent in the North Sector in the vicinity of Ngoto Swamp, Rutonde Settlement and Kishamba River. In the South Sector a major north-south cattle trail enters the forest near Ntendule Hill. Here a 2 m wide trail has been cut so that cattle can pass more easily. The vegetation and the soil have been damaged considerably. Cattle are also moved through Mubwindi Swamp and along all roads which pass through the Reserve.

3.9 FIRES IN THE IMPENETRABLE FOREST

The Impenetrable Forest is usually too moist to burn, but in exceptionally dry years, such as during 1960/61 and 1984, considerable areas may burn (Leggat and Osmaston, 1961; Butynski, pers. obser.). It is illegal to burn the vegetation in the Reserve. Nonetheless, most, if not all, fires in the Impenetrable are man made. Such fires may be set purposefully by poachers or herdsmen or accidentally by pit-sawyers, miners or honey hunters. I saw no evidence for lightning induced fires.

Recently burnt areas occurred in 6 percent of the 1 km^2 blocks surveyed. Five of the burns were in grasslands within the Reserve along the north-eastern and eastern edges of the North Sector. All five fires burnt areas in which livestock were grazed illegally in the Reserve (Section 3.8). There is no doubt that these fires were man made and that they were intended to maintain the grassland and improve the forage for livestock. In some cases the fires spread from the grassland into the forest for 50 to 100 m killing numerous trees.

Two areas of recently burnt forest were observed in the South Sector in February, 1983 (dry season). Both burns covered an area of c. 1 ha. One fire was on a shrubby hilltop (Nyamiyaga Hill) and the other in the forest (Rungu Hill). Large numbers of trees were killed by both fires. In early July, 1984, I estimated that there were at least fifteen fires burning simultaneously in the Impenetrable . . . five of these could be seen from one vantage point at Ruhizha.

3.10 AGRICULTURAL ENCROACHMENT INTO THE IMPENETRABLE FOREST

Illegal encroachment into forest reserves by agriculturalists is the major problem facing Forest Department at this time (Sections 1.2.2 and 1.3.3). It might be expected, therefore, that the Impenetrable Forest, situated as it is in a region with one of the highest human population densities in Africa, might also have this problem. This is not the case.

During this survey, only one small garden plot was found, and this belonged to miners operating illegally on Rusho Hill (Section 3.7). During 1983 one person attempted to encroach upon Mubwindi Swamp. This man was quickly evicted by Forest Department officials.

Forest Department staff charged with the protection of the Impenetrable are to be commended for an excellent job of preventing encroachers from becoming established in this Reserve.

3.11 PEOPLE TRAVELLING IN THE IMPENETRABLE FOREST

3.11.1 INTRODUCTION

A large number of people enter the Impenetrable Forest Reserve either to collect produce or simply to move from one side of the forest to the other. Most of this travel is along four sections of unpaved road that enter or pass through the forest for a total distance of 25 km (Figure 2). In addition, roads demarcate the boundary of the Reserve along three 2 km stretches. About 10 percent of the 1 km^2 blocks in the Reserve have roads entering them. Where roads are not available, an extensive network of footpaths provides access to the remainder of the Reserve.

3.11.2 ROAD FROM RUBANDA TO KITAHURIRA

The first major road into and through the Impenetrable Forest was established in 1957 primarily to service mines in the area. The Rubanda-Kitahurira Road enters the Reserve in the south-east corner of the South Sector, rises to 2,400 m in the bamboo zone (Section 3.4.2) and continues through the Reserve until about 1.5 km north-west of Ruhizha, where it forms the eastern boundary of the Reserve (Figure 2). Overall, this road runs through the Reserve for about 14 km and demarcates the boundary for another 2 km.

Between twenty and sixty people walk this road each day, the actual number being highly variable. The mean size of groups of people using this road is about five, but ranges from one to more than thirty. In addition, an average of about two large lorries travel this road each day. These trucks enter the forest primarily to haul out lumber, but they often carry large numbers of people and supplies.

3.11.3 ROAD FROM KITAHURIRA TO KAYONZA

About 100 m north of Kitahurira, the road from Rubanda enters the Reserve for the second time, as it passes through that narrow neck of forest which demarcates the South Sector of the Impenetrable from the North Sector (Figure 2). Here the road passes through the forest for 3 km and forms the boundary of the Reserve for an additional 2 km. Upon leaving the forest, it continues on to Kayonza.

This is the most heavily walked road through the Impenetrable, with sixty to one hundred twenty people passing each day. They move through in groups with a mean size of about three, but the groups observed ranged in size from one to eighteen. Vehicle use is low, however, with about one lorry passing every five days.

3.11.4 ROAD FROM KIRIMA TO ISHASHA CAMP

Near the north-east corner of the North Sector, a road from Kirima forms the boundary of the Reserve for 2 km and enters the Reserve for 1 km to end at Ishasha Camp (Figure 2). This road then becomes a major footpath which crosses the Ishasha River west to Byumba. Between ten and twenty people enter the forest on this road each day. They move in groups of one to more than five. Vehicles seldom enter the Reserve here.

3.11.5 ROAD FROM BUHOMA TO THE IVI RIVER

A relatively new road has been constructed from Buhoma in the north-west corner of the Impenetrable Forest south through the forest to the Ivi River, which demarcates the south boundary of the Reserve (Figure 2). This road, which cuts through about 6.5 km of forest, was apparently built in 1973/74 for the Uganda Tea Growers Cooperation by Baneco Company, an Italian firm. I understand that the road was built so that tea could be transported from Bufumbira (which lies to the south of the forest) to the Ntungamo Tea Factory (which lies to the north of the forest). Plans to grow large amounts of tea in the Bufumbira area did not materialize, and the road has never been used by the tea growers.

At present, only the first 3 km of this road at the Buhoma end are being maintained for vehicle traffic. Much of the remainder of this road has been overgrown by vegetation. In many places it has been severely eroded or blocked by landslides. The road does not cross the Ivi River, as no bridge has been built. Approximately 2 km of additional road must be constructed on the south side of the Ivi River before the road from Buhoma joins the road from Bufumbira near Kikobera.

The Buhoma-Ivi River Road is the major route for people moving and carrying materials between the agricultural areas to the north and south of the western half of the Impenetrable. Between forty and eighty people walk this road each day. They travel in groups with a mean size of about three. These groups vary in size from one to more than a dozen people. Approximately one large lorry enters the forest on this road every two days to haul out lumber.

The forest in the vicinity of Buhoma probably contains the highest density of large, valuable hardwoods (mahoganies and *Newtonia*) remaining in the Impenetrable. The road provides easy access to a large number of these trees, as lorries are driven 2 km into the forest to collect lumber.

This was the part of the Reserve in which I located the largest number of illegally cut trees. In seven hours of searching for large mammals during July, 1983, I located twenty-nine stumps which had been cut within the last six months. More than half of these were unstamped. Several unstamped stumps could be seen from the road. At that time, the volume of high quality wood being cut illegally in the Buhoma area was obviously large and represented both a tremendous loss of revenue to Government and lack of appropriate control by Forest Department. Before the end of 1983, Forest Department took action to reduce illegal pit-sawing near Buhoma. This was accomplished primarily by a complete change of Forest Department staff in charge of the area. During my visits to Buhoma in February and July, 1984, I found that illegal pit-sawing had been greatly reduced, but that use of the road continued to be heavy.

Each day about fifteen 20 litre jerry cans of waragi (local gin) are carried along this road, which, together with other products such as groundnuts, are apparently taken to Nyabwishenyi and then illegally across the border to Rwanda.

I first learned of the Buhoma-Ivi River Road from Harcourt (unpubl. report).

> "In 1973 a road was cut right through the forest in the far west of the Reserve, a road, incidentally, of which senior forest officers at Department head-quarters in Kabale and Kampala were apparently unaware. The access into the forest that was afforded by this road was accompanied by the heaviest intensity of logging seen anywhere in this survey. A detailed census of forestry operations in the region showed that the density of pit-saws operating at the time of the survey was 75 times the density in the Reserve as a whole."

During my own talks with the former and present Chief Forest Officers, and Forest Department personnel in Kabale, Ruhizha and Kayonza, I found that Forest Department still knew little or nothing about this road in spite of having received Harcourt's report three years earlier. In the case of the former Forest Ranger at Kayonza, this was particularly suspicious since the road is located in his region, it is heavily utilized by pit-sawyers and other people, and it lies very near his home at Buhoma.

In summary, the Buhoma-Ivi River Road has greatly increased human activities in the western portion of the Reserve and is undoubtedly having a considerable negative impact on the conservation values of this region. It is my opinion that this road was built to cater to tea growers and pit-sawyers, with no concern for what damage it might cause to the vegetation and wildlife of the region, particularly gorillas. Gorillas appear to be avoiding areas within 2 km of this road.

3.11.6 FOOTPATHS

I define a "footpath" as a trail that is obviously well used and along which I suspect an average of one or more persons pass each day. In the North Sector, where no part of the forest is more than 2 km from the boundary and thus human settlements, virtually all (96 percent) of the 1 km^2 blocks surveyed contained footpaths. Only 60 percent of the blocks surveyed in the South Sector had footpaths. This difference is likely due to the fact that much of the forest in the South Sector is more than 6 km from the nearest boundary.

Footpaths were much more prevalent in blocks within 1.4 km of the boundary (95 percent), than in blocks 1.4 to 2.8 km (60 percent), or more than 2.8 km (19 percent) from the boundary (Table 2). Correcting for differential sampling intensity of blocks located at various distances from the boundary, I estimate that 94 percent of the 1 km^2 blocks in the North Sector and 49 percent of the blocks in the South Sector have footpaths. Overall, approximately 58 percent of the 1 km^2 blocks in the entire Reserve contain footpaths. These percentages are highly conservative, since some blocks must have contained footpaths which I did not locate.

In summary, well-used footpaths provide access to about three-fifths of the Reserve. Most, perhaps all, of the remainder of the Reserve can be reached by people using less distinct paths.

3.12 SUMMARY OF HUMAN ACTIVITIES IN THE IMPENETRABLE FOREST

Evidence of human activity was found in 84 percent of the 1 km^2 blocks surveyed. This is very similar to Harcourt's (1981) results. He found human use in 85 percent of the blocks. During this survey, 94 percent of the blocks within 1.4 km of the Reserve boundary, and 74 percent of the blocks further than 1.4 km from the boundary were being utilized by people. Probably no area in the Reserve is free from disturbance by humans.

Human use of the Impenetrable appears to be on the increase. In 1979, Harcourt (1981) found signs of recent human use (*i.e.*, evidence that people had entered the area within two weeks) in 38 percent of the 1 km^2 blocks he surveyed. Four years later, based upon the present survey, it is estimated that 60 percent of the blocks were visited at least once every two weeks.

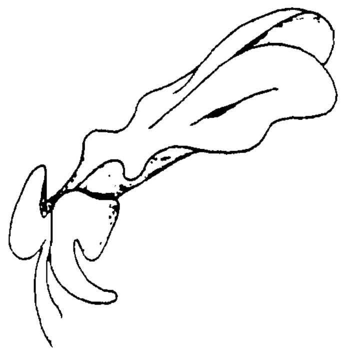
Clearly, large numbers of people enter the Impenetrable Forest for a variety of purposes; between 512 and 1049 daily (Table 5). This is a density of 1.6 to 3.2 people per km^2. The majority of these people are simply passing through the forest (c. 40 percent), or pit-sawing (c. 30 percent).

About 45 percent of the people in the Reserve are conducting illegal acts there. Furthermore, 90 percent of the activities involved removal of material (*e.g.*, wood, bamboo, livestock forage, minerals, honey, meat) are conducted illegally.

As the Working Plan for the Impenetrable Forest clearly states, conservation of the vegetation, soil, water flow and the flora and fauna, especially the gorilla, are the primary management objectives of this Reserve (Section 5.1.2). The above statistics indicate that exploitation of the Impenetrable's resources is now proceeding at a high and uncontrolled level. In simplest terms, the objectives of the Working Plan are not being met, and The Forests Act and The Game Act are often not respected.

Table 5. Estimates of the daily mean number of people in the Impenetrable Forest according to their primary activities. Data for 1983.

Legal Activities		Numbers of People
Forest Department personnel		20- 40
Game Department personnel		2- 4
Legal pit-sawyers and porters		60-120
Walking Kitahurira-Kayonza Road		60-120
Walking Buhoma-Ivi River Road		40- 80
Walking Rubanda-Kitahurira Road		20- 60
Walking Kirima-Ishasha Camp Road		10- 20
Walking on footpaths		40- 80
Travelling via vehicles		20- 45
	Sub-total	272-569
Illegal Activities		
Illegal pit-sawyers and porters		80-160
Fuelwood, bamboo and pole collectors		25- 50
Bee-keepers and honey hunters		10- 20
Miners		100-200
Poachers		20- 40
Herdsmen		5- 10
	Sub-total	240-480
	Total	512-1,049



"There are mountains in Attica that can now keep nothing but bees, but that were clothed not so long ago with fine trees, producing timber suitable for roofing the largest buildings. The roofs hewn from this timber can still be seen. There were also many lofty trees cultivated, and the country produced bountiful pastures for cattle. In those days, the annual supply of rainfall was not lost, as it is now, through being allowed to flow over a treeless and denuded surface to the sea." (Plato, 400 B.C.)

4. THE FLORA AND FAUNA OF THE IMPENETRABLE FOREST

4.1 THE IMPENETRABLE FOREST AS A PLEISTOCENE REFUGE

It is probable that during the last glacial period (between c. 25,000 and 12,000 B.P.), the climate of tropical Africa was much dryer and cooler than at present (Diamond and Hamilton, 1980; Hamilton, 1974, 1976). Most of the area in East Africa which is today forested was at that time savanna, while montane and lowland forest plants and animals were restricted to a few limited montane areas (refuges) where the climate remained suitably moist. With the wetter and warmer conditions which have persisted since c. 12,000 B.P., the forest plants and animals restricted to these refuges found conditions suitable for dispersal to lower elevations and greatly expanded their distributional ranges (Hamilton 1972, 1974).

Available evidence suggests that the most important East African refuge for forest fauna and flora during the last glacial period was in eastern Zaire and western Uganda. It is likely that the Impenetrable was part of this refuge (Figure 1).

Evidence for the Impenetrable as a Pleistocene refuge consists of the following:

1. The Impenetrable is the richest forest in East Africa for trees (Hamilton, 1974, 1976), birds (Keith, 1980; Keith et al., 1969) and probably many other taxa, including mammals (Kingdon, 1971, pers. comm.) and butterflies (Carcasson, 1964).

2. The Impenetrable contains many species of plants (Section 4.2) and birds (Section 4.3.4) not found elsewhere in East Africa.

3. East African forest floras and faunas become progressively more impoverished as the distance from the Impenetrable increases.

Hamilton (1981) says the following concerning the importance of former refuge areas to present day conservation.

> "Forest was restricted to a number of relatively small refugia during a pre-12,000 B.P. arid phase. A great increase in forest since that time has resulted in gradients of decreasing species diversity away from former refuge areas. From the point of view of species conservation, it is particularly important to conserve forests lying within those areas which retained a forest cover during the pre-12,000 B.P. arid period . . . the most important forests to conserve are those along the western margin of Uganda, in particular Bwindi-Kayonza and Bwamba Forests and, as second priorities, such forests as Kalinzu, Kasyoha-Kitomi, Kibale and Budongo."

Kingdon (1973) makes a similar plea for the conservation of former refuges.

> "It is also important to remember the zoogeographic pattern which suggests that some areas are ancient relic refuges while other areas have been more recently colonized by widespread and common dominant species. This pattern reveals that not all species nor all areas of forest are of equal value. On this criterion the forests of the greatest significance are the Bwindi-Kayonza (formerly known as the Impenetrable), Semliki, Ruwenzori, Kibale and Malambigambo forests."

4.2 FLORA

The vegetation of the Impenetrable Forest has been variously classified as follows:

Undifferentiated Moist Montane Forest	Langdale-Brown (1960)
Moist Montane Forest	Leggat & Osmaston (1961)
Tropical Low Montane Evergreen Rain Forest	Leggat & Osmaston (1961)
Parinari Forest (below 1,500 m) and Pygeum Moist Montane Forest (above 1,500 m)	Langdale-Brown *et al.* (1964)
Mixed Forest with Chrysophyllum	Lind & Morrison (1974)
Moist Lower Montane Forest	Hamilton (1982)

The tree species composition of some parts of the Impenetrable Forest has been described by Hamilton (1969) and mapped by Cahusac (1958). Data from timber trees enumerated in the southeast part of the South Sector are presented in Appendix B of Leggat & Osmaston (1961). A list of the tree species identified to date in the Impenetrable can be obtained by combining the lists in Leggat & Osmaston (1961) and Hamilton (1969, 1974). Table 6 lists some of the trees occurring in the Impenetrable.

Leggat & Osmaston (1961) noted that the vegetation of the Impenetrable was very complex and greatly affected by altitude, topography and soil depth. They went on to summarize the principal features of the vegetation of this forest as follows (also see Appendix H in Leggat & Osmaston, 1961):

Table 6. Lists of the more common trees occurring in the Impenetrable Forest, Uganda. From Lind and Morrison (1974).

Tall Tree Stratum (21- 37 m)

More important trees

Chrysophyllum gorungosanum
Entandrophragma excelsium
Newtonia buchanani
Parinari excelsa
Podocarpus milanjianus
Prunus africana
Symphonia globulifera

Less important trees

Balthasaria schliebenii
Allanblackia floribunda
Ekebergia capensis
Fagara macrophylla
Ocotea usambarensis

Trees in the Middle Stratum (9-21 m)

Albizia gummifera
Allophylus abyssinicus
Beilschmiedia ugandensis
Carapa grandiflora
Cassipourea ruwensorensis
Croton macrostachys
Dombeya goetzenii
Drypetes gerrardii
Faurea saligna
Ficalhoa laurifolia
Guarea mayombensis
Harungana madagascarensis
Ilex mitis
Macaranga kilimandscharica
Neoboutonia macrocalyx
Olea hochstetteri
Olinia usambarensis
Polyscias fulva
Dichaetanthera corymbosa
Strombosia scheffleria
Syzigium guineense
Tetrorchidium didymostemon

Trees in the Lower Stratum (0 - 9 m)

Allophylus macrobotrys
Cyathea deckenii
Psychotria megistosticta
Lobelia gibberoa
Myrianthus holstii
Rytigynia sp.
Tabernaemontana holstii
Teclea nobilis
Xymalos monospora

1. "North Block. This area is characterized by dominant, probably climax, stands of *Parinari* at 4,500 ft. elevation along the valleys of the R. Ishasha and R. Hihizo. Above this elevation, in the valleys with the better soils, is to be found *Entandrophragma* and often associated with it, *Newtonia*, *Aningeria* and *Symphonia*. In swampy areas, good stands of *Syzygium guineense* occur. *Ocotea usambarensis* occurs infrequently but, where found, is often of fair size. On the higher ridges, *Podocarpus* spp. has established itself. Along the perimeter of the forest occurs the usual colonizing mixture of *Albizia*, *Milletia*, *Canthium*, which, as one moves into a higher grade of forest, is replaced by such species as *Ficalhoa*, *Polyscias*, *Nuxia*, *Hagenia* and, in some areas, fair stands of *Maesopsis*."

2. "Southern Block. The most abundant species in this block are *Chrysophyllum* spp., associated with *Entandrophragma*, *Newtonia*, *Pygeum*, but with smaller areas of dominant *Parinari* in some of the river valley bottoms. *Podocarpus milanjianus*, previously common on all ridges, has now largely been cut out from all accessible areas in this block. Its near relative, *P. gracilior*, is, however, still to be found along swamp edges."

3. "The understory in both blocks consists mainly of *Xymalos*, *Adinandra*, *Neoboutonia*, *Myrianthus*, *Teclea*, *Allophylus*. Bamboo, *Arundinaria alpina*, occurs in small patches in the south-east of the southern block."

Hamilton (1975) states that there are about four hundred tree species known to be typical members of Ugandan forest vegetation. Of this number, more than one hundred fifty (38 percent) have been identified thus far in the Impenetrable Forest (Hamilton, 1969, 1974; Leggat & Osmaston, 1961). The few botanical surveys conducted in this Reserve must be viewed as very incomplete. Large areas, such as the western half of the South Sector, have probably never been surveyed. The non-woody species of plants are in particular need of a thorough inventory.

Four general "Flora-areas" are recognized for Uganda (Hamilton, 1974). "Flora-area 2" encompasses the Impenetrable Forest and all of western Uganda. The following data are from Hamilton (1974).

Fourteen of the fifteen species of montane forest trees in Flora-area 2 occur in the Impenetrable, including two not found elsewhere in Uganda (Table 7). Of the

c. 295 species of lowland forest trees in Uganda, 284 (96 percent) are found in Flora-area 2 and 46 are not found elsewhere in Uganda. Of these 46, eight are limited in their distribution in Uganda to the Impenetrable, and an additional ten species are only known from the Impenetrable and from scattered localities elsewhere in south-west Uganda. The Impenetrable represents the eastern most distribution in Africa for most of these latter species.

In conclusion, the Impenetrable Forest contains a high proportion of Uganda's forest tree species, including ten species not found elsewhere in Uganda. It is obvious that this Reserve is a major reservoir of tree species and thus of utmost importance to forest conservation in East Africa. This importance probably extends as well to the other forms of plant life in the Impenetrable, but too few data are available on which to base a similar analysis.

Table 7. Trees for which the distribution in Uganda is confined to the Impenetrable Forest and south-west Uganda. From Hamilton (1974).

Only found in the Impenetrable Forest

Allanblackia kimbiliensis	Leplaea mayombensis
Brazzeia longipedicellata	Maesobotrya purseglovei
Chrysophyllum pruniforme	Melchiora schliebenii
Croton bukobensis	Strombosiopsis tetrandra
Grewis mildbraedii	Xylopia staudtii

Only found in south-west Uganda (including the Impenetrable)

Cassipourea congoensis	Myrianthus holstii
Cola bracteata	Oncoba routhledgei
Drypetes bipindensis	Pauridiantha callicarpoides
Hannoa longipes	Sapium leonardii-crispi
Musanga leo-errerae	Tabernaemontana odoratissima

4.3 MAMMALS

4.3.1 GENERAL

As with many taxa of plants and animals, Uganda is unusually rich in species of mammals. There are well over one hundred species of mammals in the forests of Uganda (Kingdon, 1971, 1973). About 15 percent of these are restricted in their distribution to Western Uganda and Eastern Zaire (Bigalke, 1968). Impressed by this great diversity, Kingdon (1973) stated,

> "The total number of mammal species that may be found in Uganda's forests alone exceeds the number of species found over the whole of Europe."

The Impenetrable has not received detailed attention from mammalogists, and its small mammal fauna is in need of much further study. No species list for the mammals of the Impenetrable exists. Jonathan Kingdon (pers. comm.) has, therefore, compiled a preliminary list (Appendix D). The list includes mammals known to occur in this Reserve (Butynski, pers. obser.; Delany, 1975; Kingdon, 1971, pers. obser.; Williams, 1967). It also includes "probable" species. These are species which are, as yet, not known from the Impenetrable but which will probably be found to occur as suggested by our present understanding of their geographical range, altitudinal range, and habitat preferences.

Appendix D lists a total of 146 species of mammals. Of these, 97 species are known to occur, and 49 are "probable" species.

At this time, it seems safe to conclude that there are well over 100 species of mammals in the Impenetrable Forest. The Impenetrable undoubtedly has one of the richest forest mammal faunas in Africa. This is to be expected given its exceptional altitudinal range and its location in or near the East Zaire Pleistocene Forest Refuge (Section 4.1), the area which today has the largest number of forest mammals in Africa (Kingdon, 1971).

For the scientific (Latin) names of the mammals mentioned in this report refer to Appendix D.

4.3.2 ABUNDANCE AND DISTRIBUTION OF PRIMATES

4.3.2.1 GENERAL

The most conspicuous mammals in the Impenetrable Forest are the primates. Seven species of diurnal primates are present. In addition, at least three species of nocturnal primates occur; the potto, needle-clawed galago and Demidoff's galago. Together, these ten species present a broad spectrum of ecological and behavioral adaptations to the rain forest environment.

During this survey, the primates were given particular attention because:

1. Primates are obviously an important part of the ecosystem;

2. Except for the gorilla, little is known about the distribution and abundance of primates in the Impenetrable;

3. The chimpanzee is listed as "vulnerable" to extinction in IUCN's Red Data Book, and the mountain gorilla is classified as in danger of extinction;

4. Among the mammals, the primates, particularly gorillas and chimpanzees, are the premier tourist attraction in south-west Uganda.

4.3.2.2 METHODS

Primate Censuses

Primate distributions and abundances were assessed in many parts of the Impenetrable through the use of censuses (Figure 6). During these censuses, I walked footpaths and roads at the rate of 1 km/hr while searching for primates and other large animals. When primates were detected, I noted the:

1. location;

2. species present;

3. numbers of individuals seen of each species;

4. perpendicular distance from the census route to the first animal sighted.

I remained within 10 m of the census route at all times and spent ten minutes with each association of primates. This method of censusing primates has been used by a number of primatologists in Uganda rain forests, e.g., Butynski, in prep.; Ghiglieri, 1984; Strusaker, 1975.

The Impenetrable Forest can be sectioned into 323 1 km^2 blocks (Table 1). Based upon observations made during this survey, I estimated the area and percentage of the Reserve over which the species occurred (i.e., the species' "distribution range") (Table 8). In addition, each block was designated as being in the "interior of the forest" or "fringe of the forest," depending on whether or not it lay within 1.4 km of any road or boundary.

Opportunistic Observations

In addition to censuses, data on primates were collected whenever primates were encountered. Most such encounters occurred in the vicinity of camp, while I drove through the forest, or walked back to camp upon completion of a census. Data collected during these opportunistic observations included location, species present and numbers seen of each species.

4.3.2.3 RESULTS

General

A total of thirty-eight primate censuses were conducted along 189 km of footpath and road. Mean length of these censuses was 5.0 km, and they ranged from 0.2 to 10 km. A total of sixty-six groups of primates and three solitary adult male primates were contacted during these censuses. In addition, opportunistic observations were made on thirty-six groups and five adult solitary male primates during walks totaling 20 km within the Reserve and 54 km outside the Reserve (i.e., along boundaries and in neighboring remnant forest patches). In sum, 102 species groups and eight solitary adult males were observed during a total of 85 encounters with primates in the Impenetrable and its environs.

In the Impenetrable Forest two factors appear to be strongly associated with the abundance and distribution of primates. These are (1) altitude and (2) distance from Reserve boundaries and roads.

Table 8. Summary of census data for seven species of primates in the Impenetrable Forest Uganda (1983/84). Sightings of solitary animals not included. See text for details.

Species	km from any road or boundary	km censused WAR*	area censused WAR (km^2)	no. groups seen within MRPSD**	groups seen/km^2 WDR*** (Overall)	no. 1 km^2 blocks occupied (Total)
Redtail	<1.4	49	4.31	10	2.32	73
					(2.44)	(112)
	>1.4	17	1.50	4	2.67	39
Blue	<1.4	114	10.03	13	1.30	115
					(0.86)	(323)
	>1.4	75	6.60	4	0.61	208
Lhoesti	<1.4	114	5.47	5	0.91	115
					(0.91)	(115)
	>1.4	75	3.60	0	0.00	0
Colobus	<1.4	100	8.80	6	0.68	103
					(0.68)	(103)
	>1.4	75	6.60	0	0.00	0
Baboon	<1.4	49	3.33	4	1.20	71
					(1.11)	(96)
	>1.4	17	1.16	1	0.86	25
Chimp	<1.4	86	7.57	0	0.00	94
					(0.21)	(302)
	>1.4	75	6.60	2	0.30	208
Gorilla	<1.4	94	8.27	0	0.00	25
					(0.13)	(182)
	>1.4	75	6.60	1	0.15	157
Total	-	189	16.63	50	-	-

* WAR = "within altitudinal range"
** MRPSD = "maximum reliable perpendicular sighting distance"
*** WDR = "within distributional range"

Relationships Between Altitude and The Distribution of Primates

Blue monkeys, and probably lhoesti monkeys, are the only two diurnal primates which are found at all elevations in the Impenetrable (Table 9). Black-and-white colobus and chimpanzees occur at all altitudes up to 2,400 m and 2,300 m, respectively. Gorillas presently use the forest between 1,500 m and 2,300 m but, except for the human disturbance, would likely inhabit the highest reaches of the Reserve (2,600 m) as well as areas below 1,500 m. Baboons are limited to forest below 2,000 m and red tail monkeys to forest below 1,800 m.

The blue monkey is the most widespread primate in the Impenetrable, probably occupying all parts (100 percent) of the Reserve (Table 10). Harcourt's (unpubl. report) findings concur with this. The chimpanzee is the next most widely distributed species (present in c. 93 percent of the Reserve), followed by gorilla (c. 56 percent), lhoesti monkey (c. 36 percent), redtail monkey (c. 35 percent), black-and-white colobus (c. 32 percent) and baboon (c. 30 percent). See Figures 7 through 10 for schematic representations of the approximate distributions of these seven species in the Impenetrable Forest.

Relationships Between Altitude and the Abundance of Primates

Assessing the abundances of the seven species of primates at various altitudes is greatly complicated by the apparent affinity or aversion of each species for areas near boundaries and roads. These affinities and aversions for boundaries and roads, however, appear to hold for each species over the entire range of altitudes at which that species occurs in the Impenetrable. Based on all available data, I suggest the following associations between altitude and the abundance of primates in the Impenetrable.

Blue monkeys occur at about the same density at all altitudes with the exception of the bamboo zone (above 2,400 m), where they are probably most abundant (Table 9). Although lhoesti monkeys were not seen below 1,500 m, this species almost certainly occurs down to 1,100 m (as it does in other western Uganda forests). Lhoesti monkeys are probably equally abundant at all altitudes except above 2,400 m, where they seem most common.

Table 9. Numbers of groups of primates encountered per kilometer of census at various altitudes in the Impenetrable Forest, Uganda (1983/84). Data have been segregated for censuses run within 1.4 km of a road or boundary and for censuses conducted further than 1.4 km from any road or boundary.

titude 100m)	Redtail		Blue		Lhoesti		Colobus		Baboon		Chimp		Gorilla		Overall	
	<1.4	>1.4	<1.4	>1.4	<1.4	>1.4	<1.4	>1.4	<1.4	>1.4	<1.4	>1.4	<1.4	>1.4	<1.4	>1.4
- 15	0.55	0.24	0.18	0.00	0.00	0.00	0.55	0.00	0.27	0.12	0.00	0.00	0.00	0.00	1.55	0.24
- 18	0.21	0.24	0.13	0.24	0.13	0.00	0.03	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.52	0.59
- 21	0.00	0.00	0.08	0.00	0.00	0.00	0.08	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.20	0.04
- 24	0.00	0.00	0.20	0.06	0.10	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.33	0.10
'erall	0.12	0.04	0.15	0.05	0.08	0.00	0.09	0.00	0.04	0.01	0.00	0.03	0.00	0.01	0.48	0.13

Table 10. Preliminary estimates of the distributional ranges, densities and numbers of seven species of primates in the Impenetrable Forest, Uganda (1983/84).* Results based on 189 km of census. See text for details.

Species	% of Reserve occupied	mean group size	animals/km^2 WDR**		animals/km^2 in Reserve		Total animals in Reserve	
			uncorrected	corrected	uncorrected	corrected	uncorrected	corrected
Redtail	35	32.0	78.0	49.1	27.2	17.1	8,736	5,504
Blue	100	17.8	15.3	9.6	15.3	9.6	4,942	3,113
Lhoesti	36	17.3	15.7	9.9	5.7	3.6	1,806	1,138
Colobus	32	9.0	6.1	3.8	2.0	1.3	628	396
Baboon	30	20.0	22.2	14.0	6.6	4.2	2,131	1,343
Chimp	93	3.5	0.7	0.4	0.7	0.4	211	133
Gorilla	56	7.8	1.0	0.6	0.6	0.4	182	115
Total	-	-	-	-	58.1	36.6	18,636	11,742

* Sightings of solitary animals not included.
** WDR = "within distributional range"

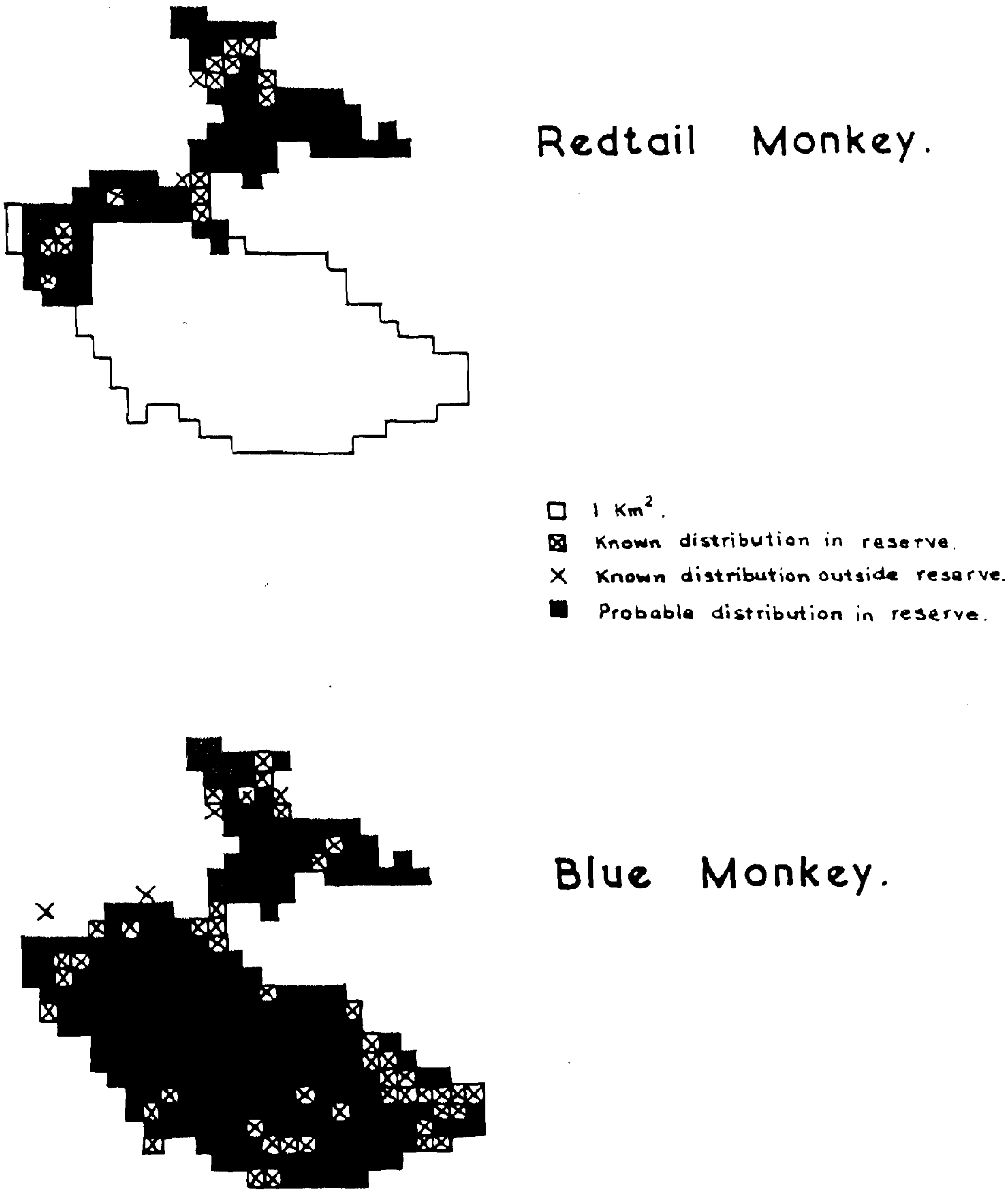


Figure 7. The known and probable distributions of redtail monkeys and blue monkeys in the Impenetrable Forest Reserve.

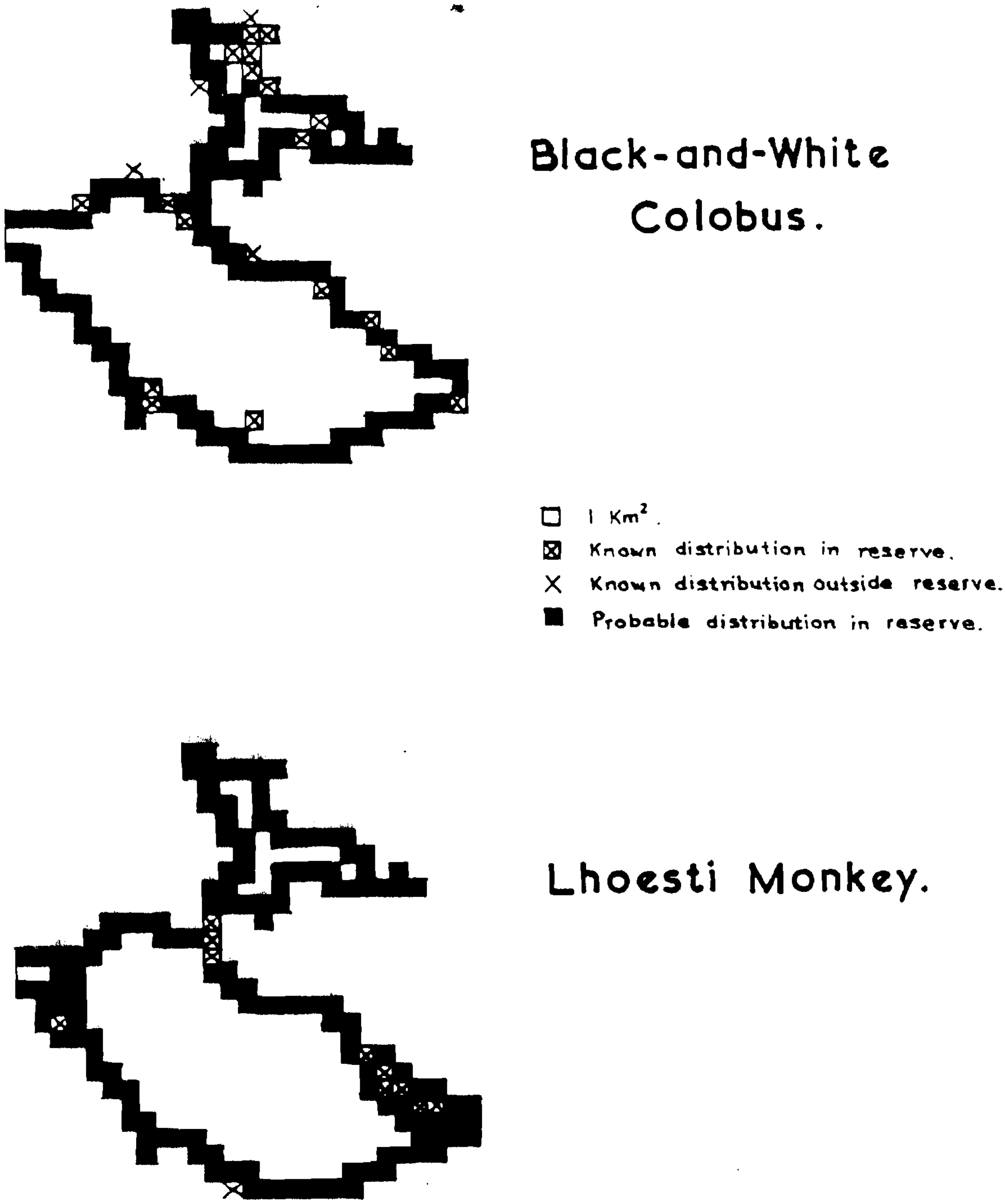


Figure 8. The known and probable distributions of black-and-white colobus and lhoesti monkeys in the Impenetrable Forest Reserve.

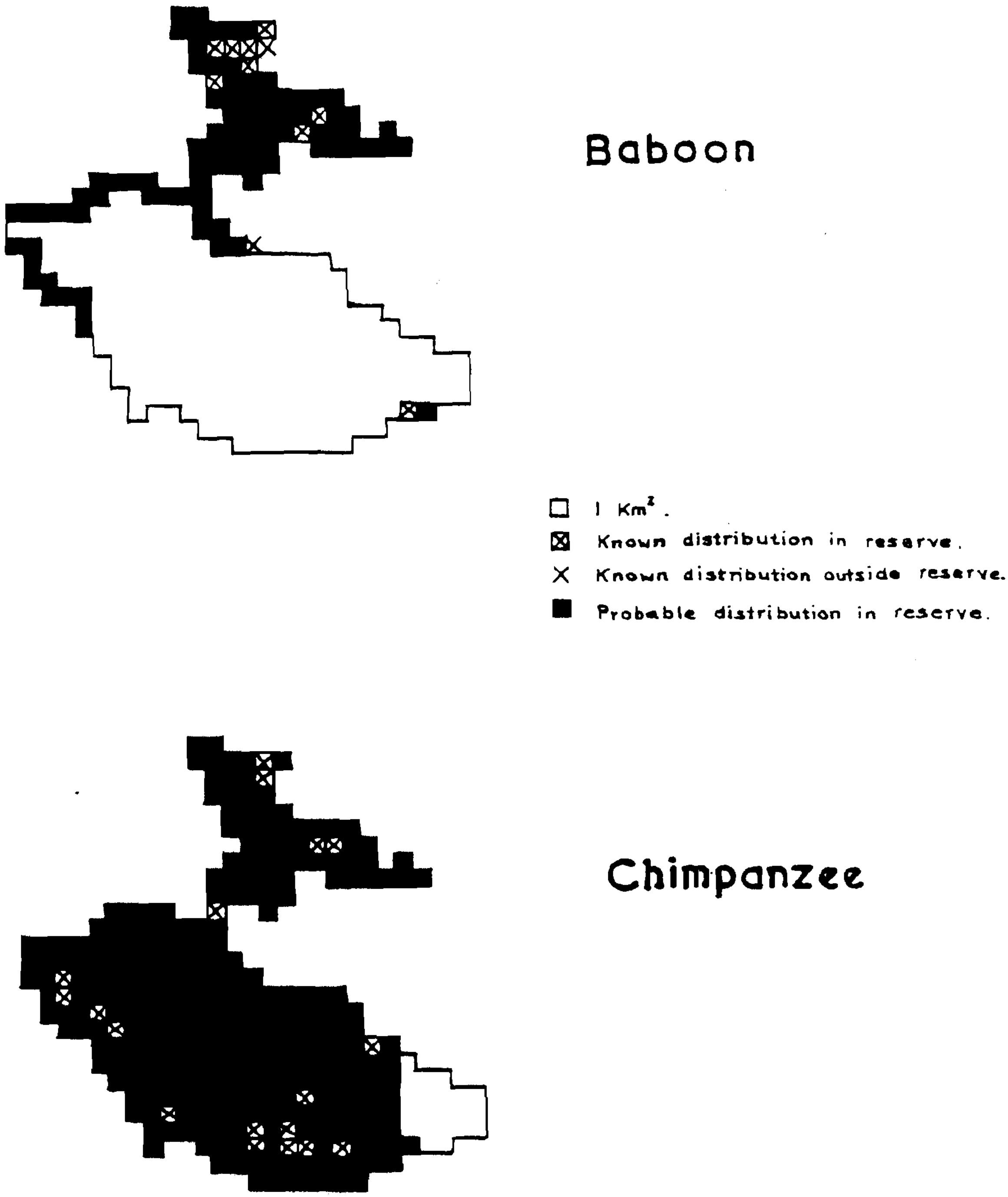


Figure 9. The known and probable distributions of baboons and chimpanzees in the Impenetrable Forest Reserve.

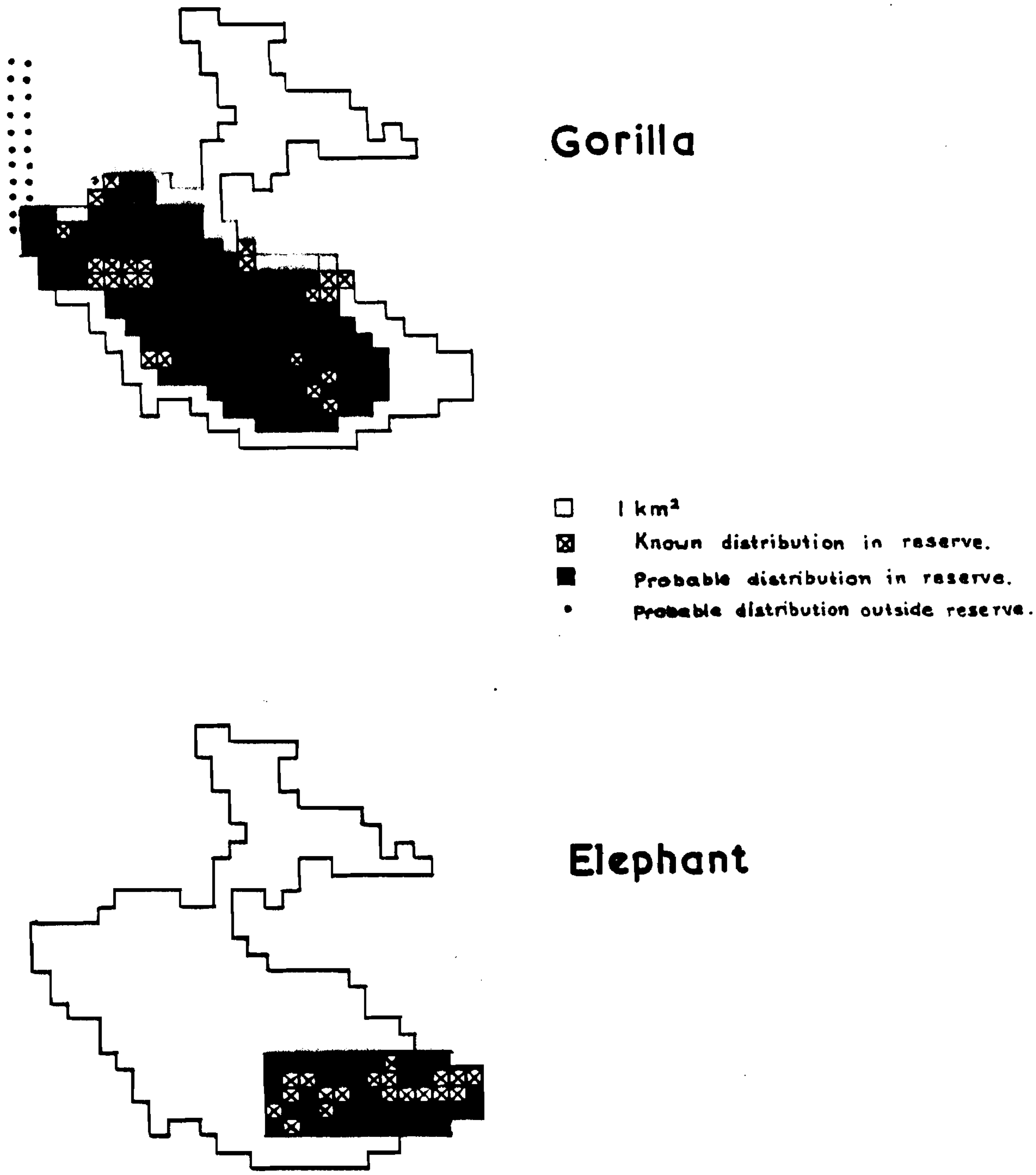


Figure 10. The known and probable distributions of gorillas and elephants in the Impenetrable Forest Reserve.

Black-and-white colobus, redtail monkeys and baboons are all most common at the low altitudes and become less abundant with increasing altitude. The evidence for gorillas and chimpanzees (i.e., vocalizations and sighting of animals, nests, trails and feeding sites) suggests that, over the range of altitude each occurs, abundance is not closely associated with altitude.

Relationships Between Roads and Boundaries and the Abundance of Primates

When I first began this survey, I was told by several Game Guards and guides in the Impenetrable Forest that the monkeys (blue monkeys, lhoesti monkeys, redtail monkeys, black-and-white colobus and baboons) were much more abundant along roads and boundaries of the Reserve (i.e., the edges of of the forest) than back in the depths of the forest. On the other hand, they claimed that gorillas were seldom seen along the roads or boundaries but kept primarily to the more inaccessible and less disturbed parts of the Reserve. The findings of this survey bear out the accuracy of this general assessment (Tables 8, 9, 11, Figures 7 - 10), as do the results of Harcourt's Survey (Harcourt, unpubl. report);

> "In contrast to the gorillas, all the monkeys were found more on the periphery than in the centre of the Reserve . . ."

Censuses were conducted along all sections of road running into or through the Reserve (Section 3.11). A total of 38 km were censused along roads and 151 km away from roads. Groups of primates were sighted approximately 3.5 times more often in forest bordering roads than in forest away from the roads. I am convinced that this difference is real and that it is not an artifact of differences in visibility.

In order to examine this interesting phenomenon further, I compared data from censuses run within 1.4 km of a road or boundary (i.e., "fringe of the forest") with data for censuses conducted further than 1.4 km from any road or boundary (i.e., "interior of the forest") (Table 8).

Except for redtails, all species of monkeys were sighted more often in the fringe of the forest than in the interior. There was no evidence that lhoesti monkeys occurred in the interior.

Table 11. Relationship between the location of 1 km^2 blocks, human use and number of blocks known to be utilized by each of seven species of primates in the Impenetrable Forest, Uganda (1983/84). Data are from censuses and opportunistic observations.

Location of 1 km^2 blocks. Distance from nearest road or boundary	No. of blocks surveyed	Redtail monkey		Blue monkey		Lhoesti monkey		B & W Colobus		Baboon		Chimp		Gorilla	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
< 1.4 km															
high use	62	10	16	27	44	10	16	15	24	8	13	6	10	3	5
1.4→2.8 km															
low use	11	2	18	2	18	0	0	1	9	0	0	4	36	4	36
high use	19	3	16	6	5	0	0	4	21	1	5	1	5	3	16
total	30	5	17	8	27	0	0	5	17	1	3	5	17	7	23
> 2.8 km															
low use	14	0	0	4	29	0	0	0	0	0	0	4	29	4	29
high use	18	1	6	4	22	0	0	0	0	1	6	3	17	4	22
total	32	1	3	8	25	0	0	0	0	1	3	7	22	8	25
Overall															
low use	25	2	8	6	24	0	0	1	4	0	0	8	32	8	32
high use	99	14	14	37	37	10	10	19	19	10	10	10	10	10	10

Black-and-white colobus were neither seen nor heard more than 2.8 km from the fringe of the Reserve. Gorillas, and perhaps chimpanzees, however, seem to prefer the interior of the forest. This basic pattern appears to hold for each species of primate at all altitudes.

Since human presence (and thus disturbance to the forest and its primates) is highest on the fringe of the Impenetrable and decreases with the distance into the forest (Table 2), it may be that those primates using the fringe prefer slightly disturbed habitats and are able to tolerate a high level of human activity. Other species, such as gorillas, may prefer less altered habitats and/or are intolerant of people.

That this is the case is suggested by Table 11. Each of the 1 km^2 blocks surveyed was ranked as to whether it was receiving "high use" by people (i.e., I estimated that an average of one or more people entered the block each day based upon all available evidence, such as use of foot-paths, extent of hunting and pit-sawing, etc.) or "low use." Blocks in which human disturbance was relatively high appeared to be preferred by all five species of monkeys, whereas gorillas and chimpanzees seemed to be avoiding these areas.

Primate Densities and Numbers

I estimate that nearly all groups of blue monkeys, redtail monkeys, black-and-white colobus, chimpanzees and gorillas occurring within 44 m of either side of the census route were detected. This "maximum reliable perpendicular sighting distance" (MRPSD) was estimated at 34 m for baboons and 24 m for lhoesti monkeys. Except for gorillas, the MRPSD's used here are the same as I have established for these primates in Kibale Forest (Butynski, in prep.).

With knowledge of the MRPSD's, numbers of primate groups observed within the MRPSD, length of the census, and distribution of each species in the Reserve, the density of primate social groups can be estimated from census results (Table 8).

As indicated earlier in this section, all seven species of primates appear to have a preference for either the fringe or the interior of the forest. Primate densities were, therefore, estimated in both areas (i.e., in areas within 1.4 km of any boundary or road, and in areas more than 1.4 km from any boundary or road) to help correct for the considerable bias this phenomenon would have on estimating densities from census data. The density of each species in fringe and interior habitants was then multiplied by the number of fringe and interior 1 km^2 blocks believed to lie within the "distributional range" of the species in the Impenetrable (Tables 8 and 9).

To correct for the fact that most species of primates do not occur at all altitudes within the Reserve, I used data taken only from those censuses conducted at altitudes at which the species occurred (i.e., within the "altitudinal range") (Tables 8 and 9). For example, redtail monkeys are not found above 1,800 m. Thus, all censuses run above 1,800 m (i.e., outside the "altitudinal range") were excluded from the analysis of redtail monkey densities.

The mean total area of a species' distributional range within the Impenetrable which was censused was 11.5 km^2. This varied from 4.5 km^2 for baboons to 16.6 km^2 for blue monkeys (Table 8). The mean percentage of a specie's distributional range within the Impenetrable which was censused was 5.9 percent. This varied from 4.7 percent for chimpanzee and baboons to 8.5 percent for black-and-white colobus.

It is more usual, and often more useful, to refer to animal densities in terms of individuals per unit area rather than groups per unit area. This is especially true when comparing species which differ greatly in the mean size of their social groups, as do the seven species of primates considered here.

Except for gorillas, the mean group size for each species (Table 10) was derived from a large number of complete group counts in Kibale Forest by Butynski (unpubl. data), Ghigliere (1984) and Strusaker and Leland (1979). My impression is that group sizes in the Impenetrable are similar to those observed in Kibale. During this survey, I obtained two complete counts of lhoesti monkey groups (17 and 22 animals) and six complete counts of black-and-white colobus groups (3,7,7,7,8, and 8 animals). Means of these counts are similar to those for these two species in Kibale.

Mean size of gorilla groups was obtained by counting nests that gorillas built to sleep in at night. Harcourt (1981) counted four groups of nests (6,8,10 and 11 nests), and I counted nine groups of nests (2,2,3,4,7,7,9,10 and 21 nests).

The "uncorrected" estimates of primate densities as derived from the "maximum reliable perpendicular sighting distance" (MRPSD) method are given in Table 10. Since censuses along each transect in the Impenetrable were seldom repeated, it is impossible to determine the variability of the census results and, thus, their precision. Likewise, the absence of detailed studies of specific groups of primates in the Impenetrable make it impossible to assess the accuracy of the estimates of primate densities obtained during this survey. According to Struhsaker (1981b), the estimates of primate densities derived from surveys using the "MRPSD" method are usually overestimates. He suggests (Strusaker, 1975) that primate densities in Kibale Forest are overestimated by about 37 percent when this method is employed.

Of the few areas where densities have been accurately determined, the Kibale Forest is most similar to the Impenetrable in terms of forest type and the compositions of the primate community. To help avoid the very real danger of overestimating the numbers of primates in the Impenetrable, the densities and numbers expressed in Table 10 have been "corrected" by reducing them 37 percent.

It is obvious from the above calculations, and the use of a gross correction factor, that the "corrected" values for primate densities and numbers in the Impenetrable are but very preliminary and rough estimates. Utmost caution must, therefore, be taken in the use of these figures. This point must be stressed by anyone referring to these data.

The most common primate in the Impenetrable Forest is probably the redtail monkey. This species is represented by c. 49 individuals per km^2 within its distributional range and by c. 17 individuals per km^2 in the Reserve as a whole (Table 10). There are roughly 5,500 redtail monkeys in the entire Reserve. Redtail monkeys are likely followed in abundance by blue monkeys, baboons, lhoesti monkeys, and black-and-white colobus. The two species occurring at the lowest density and number are the two largest primates; chimpanzees and gorillas.

Once again, extreme care must be taken in evaluating these results, especially for chimpanzees and gorillas, as the size of the sample is very small and, thus, susceptible to considerable random error. Chimpanzees were encountered only twice during censuses and gorillas but once. If I had chanced upon gorillas twice during the censuses, the number of gorillas estimated to occur in the Impenetrable would be twice as great as stated in Table 10 (i.e., 230 animals rather than 115). On the other hand, if I had failed to encounter gorillas during censuses, the implication would be that there were no gorillas in the Impenetrable.

From censuses, it is estimated that there are about 37 diurnal primates per km^2 in the Impenetrable, or about 12,000 diurnal primates in the entire Reserve (Table 10). This is a low density of primates when compared with some other western Uganda rain forests. For example, the several areas censused in Kibale Forest contain from 300 to more than 600 diurnal primates per km^2 (Butynski, unpubl. data; Struhsaker and Leland, 1979). Much of this difference is probably attributable to the higher mean altitude in the Impenetrable and to the consistently low primate densities above 1,700 m. One obvious difference between the Impenetrable and Kibale is the considerably lower density of fruit for primates in the Impenetrable, particularly figs (*Ficus* spp.). This was especially evident above 1,700 m.

4.3.2.4 PRIMATE POLYSPECIFIC ASSOCIATIONS

Two species of primates were considered to be in polyspecific association when they were found to be within 30 m of one another.

Primates were encountered on 85 occasions in the Impenetrable Forest. Eight (9 percent) of these encounters were with solitary adult males, 56 (66 percent) were with single species groups, 17 (20 percent) were with associations of two species, and 4 (5 percent) were with associations of three species of primates (Table 12).

The mean number of species present per encounter was 1.3. Overall, 25 percent of the encounters were with primates in polyspecific associations. The two most common

Table 12. Summary of 85 observer encounters with seven species of primates in the Impenetrable Forest, Uganda (1983/84).

Species	Solitary adult males* No.	%	Groups not in polyspecific association No.	%	Groups in association with one other species No.	%	Groups in association with two other species No.	%	Total groups
Redtail monkey	4	15	7	27	11	42	4	15	26
Blue monkey	4	11	14	39	14	39	4	11	36
Lhoesti monkey	0	0	11	69	3	19	2	12	16
B & W colobus	0	0	12	67	5	28	1	6	18
Baboon	0	0	9	90	1	10	0	0	10
Chimpanzee	0	0	2	67	0	0	1	33	3
Gorilla	0	0	1	100	0	0	0	0	1
Total or %	8	7	56	51	34	31	12	11	110

* none of the eight solitary adult males were in association with other species.

primates, redtail monkeys and blue monkeys, were also the two species most often present in polyspecific associations. These two species were involved in 45 percent of the twenty-one polyspecific associations observed (Table 13).

Smaller primates tended to be in polyspecific associations considerably more frequently than larger species (Tables 12 and 13). The four smallest species (redtail monkeys, blue monkey, lhoesti monkey, black-and-white colobus) were in polyspecific associations during 46 percent of the encounters. In contrast, the three largest species (baboon, chimpanzee, gorilla) were in polyspecific associations during but 14 percent of the encounters.

4.3.2.5 SUBSPECIES OF CERCOPITHECUS MITIS

The literature indicates that three subspecies of Cercopithecus mitis might occur in the Impenetrable Forest; Stuhlmann's blue monkey (C. m. stuhlmanni) (Hill, 1966; Stott, 1960; Williams, 1967), Doggett's monkey (C. m. doggetti) (Hill, 1966; Kingdon, 1971; Stott, 1960), and the golden monkey (C. m. kandti) (Stott, 1960; Williams, 1967).

It is now reasonably certain that the golden monkey does not occur in the Impenetrable because it has never been seen there.

Kingdon (1971) states that,

> "Some C. mitis monkeys in the forests south of Lake Edward are somewhat intermediate in colouring between C. m. doggeti and C. m. stuhlmanni. Whether this is due to a clinical gradient or interbreeding between formerly isolated races is difficult to say, but confused field identifications of monkeys from this area (Stott, 1960) have led to the belief that the races are sympatric in this area (Hill, 1966). This is not the case."

Within the Impenetrable, I have seen animals which are "good" C.m. stuhlmanni (i.e., with silver-gray backs with no tinge of olive), as well as those which are "good" C.m. doggeti (i.e., with distinctive olive-yellow backs). In addition, many individuals intermediate in form between these two extremes are present (i.e., with at least a slight tinge of olive on silver-gray backs).

Animals which can be classified as C.m. stuhlmanni, C.m. doggeti, and forms intermediate between the two, can be seen within the same group. I was able to

Table 13. Summary of 21 polyspecific associations among seven species of primates in the Impenetrable Forest, Uganda (1983/84). The incidence of each pair-wise combination is given.

Species	Redtail Monkey	Blue Monkey	Lhoesti Monkey	B & W Colobus	Baboon	Chimpanzee
Blue monkey	13	-				
Lhoesti monkey	2	5	-			
B & W colobus	3	3	0	-		
Baboon	0	0	0	1	-	
Chimpanzee	1	1	0	0	0	-
Gorilla	0	0	0	0	0	0

The following "three species associations" are included in the above:

redtail monkeys and blue monkeys and lhoesti monkeys (n=2)

redtail monkeys and blue monkeys and chimpanzees (n=1)

redtail monkeys and blue monkeys and colobus (n=1) observe thirty groups of C.mitis under good conditions of visibility and lighting (although I seldom, if ever, saw all the individuals in each group). In eighteen of these groups, I only saw individuals which had the coloring of the backs ranging from a very slight tinge of olive to a strong olive-yellow. I classified all such animals as C.m. doggetti but the individuals with very slight tinge of olive could be considered as intermediate between the two "subspecies."

In nine groups I observed only individuals which had silver-gray backs without an olive tinge, and these I considered to be C.m. stuhlmanni. In three groups I saw intermediate forms as well as good representatives of both "subspecies."

Both "subspecies" occur at all altitudes. Thus far, I have not observed any relationship between altitude, location or habitat type in the Impenetrable, and the "subspecies" which is found there.

In conclusion, individuals representative of C.m. stuhlmanni and C.m. doggetti occur in this population. However, there is considerable interbreeding between these two "subspecies" and most individuals appear intermediate in coloration. Because of this, it seems more suitable to view C. mitis in the Impenetrable as consisting of one population with considerable color polymorphism rather than two populations of sympatric subspecies (Hill, 1966; Stott, 1960). Thus Kingdon (1971) appears correct in asserting that the two subspecies are not sympatric in this area, at least not in the sense that they are reproductively isolated.

4.3.2.6 MOUNTAIN GORILLAS

Population Size

Of the three subspecies of gorilla (Gorilla gorilla), the mountain gorilla (G.g. beringei) is, by far, the most endangered (Harcourt et al., 1983). Mountain gorillas occur only in the 375 km^2 Virunga Volcanoes area of Rwanda, Zaire, and Uganda, and in the Impenetrable Forest. The Virunga population declined by about 40 percent between 1960 and the early 1970's (Harcourt and Fossey, 1981), and by 7 percent from 1973 to 1981 (Harcourt et al., 1983; Aveling and Harcourt, 1984). The present population of gorillas in the Virungas is about 250. The number of gorillas in the Impenetrable Forest is reported to have decreased from approximately 150 individuals in

1959 (Schaller, 1963) to 115 in 1979 (Harcourt, 1981), a 23 percent decline in only twenty years.

I combined my data with that of Harcourt (1981) to increase the data base. Using nest counts, we found evidence for 101 gorillas in the 126 1 km^2 blocks surveyed within the gorilla's range in the Impenetrable. This yields a density of c. 0.8 gorillas per km^2, or a total population for the forest of approximately 146, if my estimate that gorillas use 182 km^2 of this Reserve is used. This figure is similar to Schaller's (1963) estimate for this population in 1959. Until a detailed study of the population of gorillas in the Impenetrable can be undertaken, the number of gorillas remaining will continue to be disputed. My present understanding of the size and rough distribution of several groups of gorillas in this Reserve suggests that there are still between 100 and 150 individuals.

Because of the small numbers of gorillas remaining and their great importance, I believe it wise to take a conservative view and to manage this species on the basis of 115 animals (Harcourt, 1981) until an accurate assessment of this population can be made.

Regardless of the actual number of mountain gorillas in the Impenetrable, they represent approximately one-third of the world's total population of 300 to 400 animals. In terms of conservation and management of this forest, therefore, the mountain gorilla is of major importance. Because of this, I will examine here what we know concerning gorillas in the Impenetrable.

Group Size

Data on size of gorilla groups in the Impenetrable are summarized in Table 14. These data are based on direct observations or nest counts.

Table 14. Sizes of gorilla groups in the Impenetrable Forest

GROUP SIZES	MEAN SIZE	SOURCE
4,5,8,20*	9.2	Pitman (1935)
5,13,17	11.7	Kawai & Mizuhara (1959)
2,5,5,7,8,12,15	7.7	Schaller (1963)
6,8,10,11	8.8	Harcourt (1981)**
2,2,3,4,7,7,9,10,21	7.2	Butynski, this survey (1983-84)
5,7,7,8,12,16	9.2	Game Guards Bunengo and Mutambuka (1983)

* Pitman (1935) refers to a group "of nearly two dozen" gorillas. I use 20 here to represent this group.

** In addition, Harcourt (1981) found one group of four gorillas outside the Reserve.

The mean group size for the 33 groups cited in Table 14 is 8.5 gorillas, and the range is 2 to 21. This is similar to the mean size of 28 gorilla groups in the Virunga Volcanoes (mean = 8.8, range = 3 - 21) (Weber and Vedder, 1983).

The mean size of ten groups of gorillas counted in the Impenetrable prior to 1961 was 9.0 animals, whereas the mean size of nineteen groups counted after 1978 was 8.2 animals. These two means are similar. This tentatively suggests that group size of gorillas in this Reserve has probably changed little in the last two decades.

Based upon information from four groups, Harcourt (1981) stated that the size and composition of the groups in the Impenetrable

> "were similar to those in the Virunga Volcanoes, the nearest region where gorillas occur. In both areas, size and composition were varied but averaged 1 adult male, 3-4 adult females and 4-5 immature animals. . ."

Harcourt (1981) found that, among four groups of gorillas encountered in the Impenetrable, 68 percent of the animals were adults. He suggested that only about 75 adults were present in this population.

Past Distribution

We have little information on the distribution of gorillas in south-west Uganda prior to 1933. However, it is possible to provide a reasonable hypothetical reconstruction of the past range of gorillas in this region based upon what we know of the habitat requirements of gorillas in the Impenetrable and the vegatational history of south-west Uganda.

Today, suitable gorilla habitat in the Impenetrable occurs over the elevational range from 1,500 to 2,600 m. There is nothing outstandingly different between the terrain, altitude or climate of the Impenetrable and most of south-west Uganda to the east (to Kisiizi, Mpalo and Kabale) and south (to the Virunga Volcanoes) except that the Impenetrable is the only large tract of forest remaining in the region. Since all of south-west Uganda was once forested (Lind, 1956), and nearly all of this region is over 1,500 m, it is possible that gorillas previously occupied eight to ten times more range in south-west Uganda than they do today, perhaps as much as 1,800 km^2.

There appears to be but one primary reason why gorillas do not occupy a much larger range in south-west Uganda . . . virtually all of the forest has been removed by man. I estimate that more than 95 percent of the forest here has been eliminated. The felling of forest in south-west Uganda began on a massive scale sometime after 1860, when Bakiga and other agriculturalists entered the region from Rwanda (Purseglove, 1950).

It is certain that the habitat available for gorillas in the vicinity of the Impenetrable has declined considerably during the last half century. In 1933/34 Pitman (1935) made observation on gorillas in a tract of forest which was contiguous with the south-west border of the Reserve. He estimated that forty to fifty gorillas lived here. In 1935 Pitman proclaimed,

> "There is little likelihood in the immediate future of serious conflict between man and gorilla in the dense uninhabitable valleys to the west of this river [the Kashasha] and in the vicinity of the Belgian Congo Border."

Unfortunately, since 1935 this tract of forest has been felled and settled by agriculturalists . . . the gorillas have been eliminated. During the past fifty years similar events have occurred over a large area of what was probably former gorilla range in the vicinity of the Impenetrable. As mentioned previously (Section 3.4.1), approximately 83 percent of the natural forest present on public lands in this region in 1954 has since been destroyed. The only notable exception is a strip of forest on the Arusuru-Nuundu Ridge at the north-west corner of the South Sector of the Impenetrable (Section 5.2.3.3).

Present Distribution

I have been unable to find any reference to the occurrence of gorillas in the North Sector of the Impenetrable. Most of this area is well below 1,500 m and therefore may represent unsuitable habitat for gorillas, but this is far from certain. Both Harcourt (1981) and I feel that the great amount of human activity which occurs in the narrow neck of forest connecting the South Sector with the North Sector (Figure 2) may be preventing gorillas from using the North Sector (Section 3.11.3).

Harcourt (1981) estimated that gorillas were using c. 235 km^2 (73 percent) of the Reserve in 1979. This, I believe, is an over-estimate of about 50 km^2. It appears that Harcourt was liberal in his assessment of the area used by gorillas and included about 50 km^2 of forest fringe into his calculations. These fringe blocks may still be used rarely and briefly but are currently of little importance to the gorilla population.

Gorillas now use c. 182 km^2 of the South Sector of the Reserve (Figure 10). This is about 70 percent of the South Sector, or 56 percent of the whole Reserve. Areas of the South Sector not used are along the periphery of the Reserve and the Rubanda-Kitahurira Road. These areas appear suitable for gorillas, but are subjected to considerable human use (Table 11). High levels of human activity are probably preventing gorillas from making full use of the South Sector.

Harcourt (1981) reached the same conclusion. He found that

> "gorillas and the local people used different areas of the Reserve: signs of the presence of gorillas were far less common in squares [i.e., 1 km^2 blocks] where there was recent human use than where there was no such use." " . . . the conclusion appears inescapable that in the Bwindi Forest Reserve conflict exists at the present time between the local people and the gorilla, and that human use of the forest is excluding gorillas from areas that they would otherwise enter."

4.3.3 ABUNDANCE AND DISTRIBUTION OF LARGE MAMMALS OTHER THAN PRIMATES

4.3.3.1 METHODS

During primate censuses and other activities in the Reserve, I noted all sightings or spoor of other large mammals within all 1 km^2 blocks entered.

4.3.3.2 ELEPHANT

It seems certain that elephants once roamed throughout the Impenetrable Forest (Section 3.6.3). Today, however, they are absent from large portions of the Reserve, including the entire North Sector. I was told that elephants occurred in the North Sector until about thirty years ago. At present, they are confining their activities to the highest reaches of the forest in the south-east corner of the South Sector. The Game Guards indicated that, as of 1977, elephants occasionally moved as far as 10 km north and northwest of Mubwindi Swamp (to near Kitahurira). I saw no evidence that such movements still occur.

The area now used by elephants consists of about 61 km^2, or about 19 percent of the Reserve (Figure 10). The area most intensively used includes the bamboo zone, Mubwindi Swamp and the surrounding forest. This area is now critical for the survival of elephant in the Impenetrable.

I observed or heard elephants, or found spoor less than two months old, in 15 percent of the 1 km^2 blocks surveyed (Table 15). Elephants showed a strong preference for areas away from the fringe of the Reserve and with low human disturbance (Table 15). They used only 6 percent of the fringe blocks but 34 percent of the blocks located more than 2.8 km from any boundary or road. Ten percent of the blocks with high human activity were used by elephants, compared to 36 percent for blocks in which human activity was low.

The Chief Game Warden (pers. comm.) reports that in 1981 he watched thirty elephants cross the Rubanda-Kitahurira Road. Game Guard Bunengo estimates that there are now about thirty elephants in the Impenetrable. My impression is that there are fewer than thirty elephants remaining. On one occasion I encountered a herd of seven elephants (three adult females, two sub-adults and two juveniles).

Habitat loss and poaching have brought the elephant population in the Impenetrable to a critically low level. The Game Guards showed me the skeleton of one elephant which they claim was shot by poachers in 1974. One Game Guard said that there were elephants in the western half of the Reserve until 1976, when a large number of poachers entered from Zaire and shot many. I received two reports of elephants being shot during 1983, but did not have the opportunity to confirm them.

It is obvious that the elephant is in extreme danger of extinction in the Impenetrable. Immediate action is needed to provide a high degree of protection to this species. The loss of elephants from the Impenetrable will mean the loss both of a major component of the ecosystem and a potentially important tourist attraction.

4.3.3.3 BUFFALO

Although buffalo were probably once widespread in the Impenetrable (Section 3.6.3), they no longer occur there. Local people indicated that buffalo were present in the North Sector until about thirty years ago, and that they have been absent from the west and south-west parts of the South Sector for more than thirty-five years. Struhsaker (pers. comm.) saw signs of buffalo in the bamboo zone in 1970, but the species was exterminated in the Reserve soon after that, probably in 1971, according to Game Guard Bunengo. Their extinction in the Impenetrable is likely the result of poaching.

Table 15. Relationships between the location of the 1 km^2 blocks surveyed, human use, and number of blocks utilized by each of four species of large mammals. Data are for the Impenetrable Forest, Uganda (1983/84).

Location of 1 km^2 blocks. Distance from nearest road or boundary	No. of blocks surveyed	Elephant		Duiker		Bush-pig		Giant hog	
		No.	%	No.	%	No.	%	No.	%
$<$ 1.4 km									
high use	62	4	6	3	5	6	10	0	0
1.4 → 2.8 km									
low use	11	1	9	3	27	3	27	0	0
high use	19	3	16	1	5	1	5	0	0
total	30	4	13	4	13	4	13	0	0
$>$ 2.8 km									
low use	14	8	57	3	21	7	50	1	7
high use	18	3	17	5	28	1	6	0	0
total	32	11	34	8	25	8	25	1	3
Overall									
low use	25	9	36	6	24	10	40	1	4
high use	99	10	10	9	9	8	8	0	0

4.3.3.4 BUSHBUCK

I did not see or hear bushbuck in the Impenetrable Forest. All reports indicate that the only place in the Reserve where bushbuck are still found is in the vicinity of the remote Mubwindi Swamp (Figure 11). In other words, bushbuck are probably present in less than 1 percent of the Reserve.

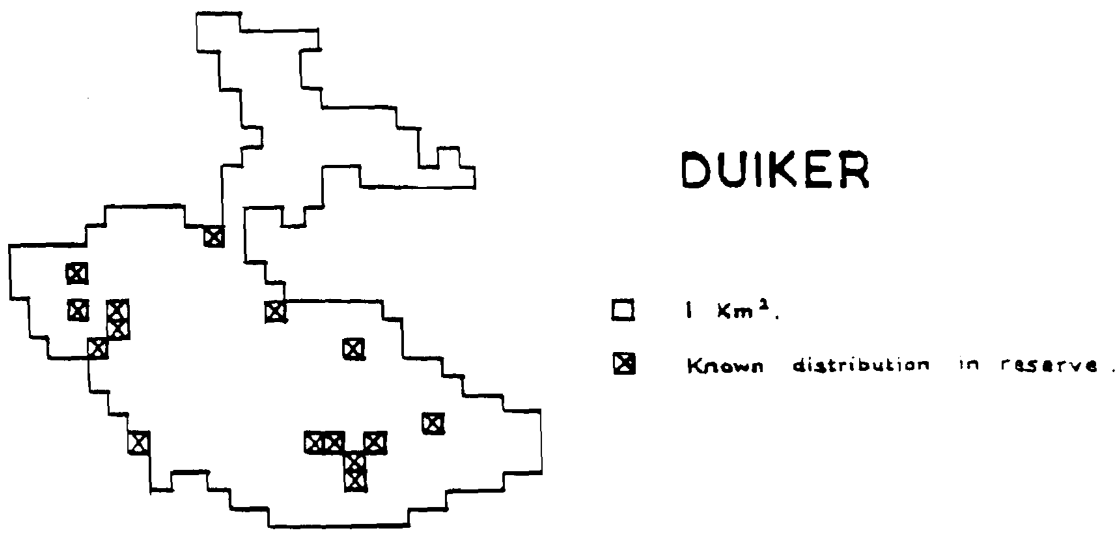
I spent four days surveying the area around Mubwindi Swamp but did not see or hear this species or encounter its spoor. During a visit in 1983 to Mubwindi Swamp, Jan Kalina (pers. comm.) heard a bushbuck bark. The Game Guards assured me that bushbuck still occurred there.

4.3.3.5 DUIKERS

It is still uncertain which species of duikers are present in the Impenetrable Forest. Kingdon (1971), Pitman (1935), Williams (1967), and many local people state that the black-fronted duiker is here, and I have seen the skin of this animal in households near the forest. The yellow-backed duiker also occurs (J. Kingdon, pers. comm.) in the South Sector and may be widespread. Several local people claimed that the red duiker, but not the black-fronted duiker or yellow-backed duiker, is found in the North Sector. That the red duiker is in the North Sector would not be surprising, as it is an abundant species in Kalinzu Forest (J. Kingdon, pers. comm.). Unexpectedly, there were no reports of blue duiker in the Impenetrable.

Duikers are uncommon throughout the Impenetrable. They seem to be entirely absent from the North Sector. Their spoor was found in only 15 percent of the South Sector blocks, or 12 percent of the entire Reserve (Figure 11). Because duikers probably move over very limited areas, it is likely that their presence in many 1 km^2 blocks was overlooked and that their range, therefore, is considerably greater than indicated above. I suspect that a detailed search of each block would reveal that nearly all blocks in the South Sector are used somewhat by duikers, although at a very low level in all cases.

Duikers were most evident in those parts of the forest far from the fringe of the Reserve as well as in places where human activities were lowest (Table 15). Twenty-five percent of the blocks located more than 2.8 km into the Reserve were used by duiker, while only 5 percent of the blocks on the fringe of the Reserve were being used. Duikers were found in only 9 percent of the 1 km^2 blocks



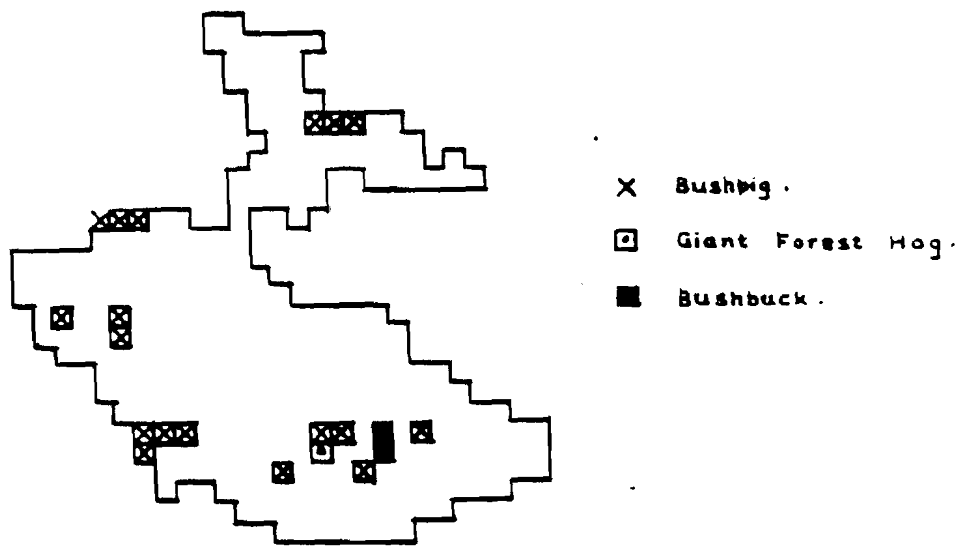


Figure 11. The known distributions of duiker, bushbuck, bushpig and giant forest hog in the Impenetrable Forest Reserve.

with high human disturbance, but in 24 percent of the blocks with low human disturbance.

Compared with some other forests in western Uganda, the density of duikers in the Impenetrable is extremely low. J. Kingdon (pers. comm.) visited the Impenetrable in 1984 and found duiker densities to be far lower than in the late 1960's. I suggest that the present density of duikers is far below the carrying capacity of the Reserve, and that intense poaching pressure is primarily responsible (Section 3.6.2).

4.3.3.6 LEOPARD

Pitman (1935) reported leopards in the Impenetrable Forest in 1933/34. Game Guards and local people claim that leopards were last seen in the North Sector about thirty years ago, and that they disappeared from the western and eastern part of the South Sector in about 1972.

My survey indicated very low densities of leopard prey species, such as duikers, bushbuck, wild pig, giant forest hog, guinea fowl or francoline. This may be due largely to heavy poaching of these species. Low numbers of prey may have indirectly exterminated the leopard, though poaching could also have had a direct negative effect on leopards.

4.3.3.7 BUSHPIG

The bushpig is well known for its resilience to human disturbance, particularly hunting. Nonetheless, even bushpigs must be classified as uncommon in the Impenetrable. Because bushpigs produce considerable spoor, the absence of spoor in a 1 km^2 block is a good indication that bushpigs are either not present or in very low numbers there.

Bushpig spoor was detected in 13 percent of the 1 km^2 blocks surveyed in the North Sector and 15 percent of those surveyed in the South Sector, or 15 percent of all sampled blocks. Bushpigs did, however, seem to be locally common over small areas. These include an area north of Nyamigazhu Hill in the North Sector, and Rugizi River, Nyaigulu Hill, Kasatora Hill and Ibaare Hill in the South Sector.

As with all large mammals sought by poachers, bushpigs were most abundant in areas far from the fringes of the forest, and where there was little human influence (Table 15, Figure 11). Bushpigs used 8 percent of the 1 km^2 blocks on the fringe of the Reserve, but 25 percent of those blocks located more than 2.8 km from a boundary or road. They were detected in only 8 percent of the blocks with heavy human disturbance, compared to 40 percent of the blocks where disturbance was low.

4.3.3.8 GIANT FOREST HOG

The giant forest hog is certainly one of the rarest large mammals in the Impenetrable (Table 15). This species was encountered only once; along Rugezi Stream about 4 km west of Mubwindi Swamp (Figure 11). This is perhaps the most remote place in the Reserve, and human disturbance here is relatively low. Heavy poaching has likely relegated this species to one or a few of the least accessible tracts of forest in the Reserve.

4.4 AVIFAUNA

Because of its considerable altitudinal range, and because it was probably part of a Pleistocene refuge (Section 4.1), the diversity of bird species in the Impenetrable Forest is extremely high. Indeed, this Reserve probably holds the richest forest avifauna in Africa (Friedmann & Williams, 1970; Keith et al., 1969; Moreau, 1966), while possessing a particularly rich and important montane forest avifauna (Keith, 1980).

Prior to this survey, the bird checklist for the Impenetrable consisted of 284 species (Friedmann and Williams, 1970; Keith et al., 1969), 175 of which are true forest species (Keith, 1980). Thus, this forest has 43 percent of the 409 forest species listed for the Ethiopian region (Keith et al., 1969; Moreau, 1966). What is perhaps most interesting is that the Impenetrable harbors at least seventy montane forest species, or 90 percent of the 78 montane forest species in the East Congo Montane Region, and 58 percent of the 120 montane forest species in the whole of Africa (Keith, 1980).

Concerning the extraordinary avifauna of the Impenetrable, Kingdon (1973) points out that,

> "it is possible in a segment of one forest in a tiny corner of Uganda to see a greater variety of birds than in the whole of Britain."

Although there are no genera or species of birds known to be endemic to this forest, and but one endemic sub-species (the black-backed apalis, *Apalis rufogularis kigezi*), this Reserve is of particular importance because it holds at least eighteen (78 percent) of the twenty-three endemic species of montane forest birds in the East Congo Montane Region (Keith, 1980).

The bird checklist for the Impenetrable contains a number of rare species and many species not known from elsewhere in East Africa (Friedmann and Williams, 1968, 1970; Keith, 1968; Keith and Twomey, 1968; Keith et al., 1969; Macworth-Praed and Grant, 1960). The following three species are listed as "rare" or "vulnerable" in the International Council for Bird Preservation's African Red Data Book and, therefore, are given special consideration here.

1. African Green Broadbill (Pseudocalyptomena graueri). Rare. Known only from two other mountain ranges. In the Impenetrable, this broadbill is only known to occur in the vicinity of Mubwindi Swamp (2,100 m).

2. Chapin's Flycatcher (Musicicapa lendu). Rare. Known only from three other localities. In the Impenetrable, it is found at 1,500 m. The Red Data Book states that this bird is suffering from forest clearance, especially in the Impenetrable.. It calls for much stricter forest conservation measures throughout its range.

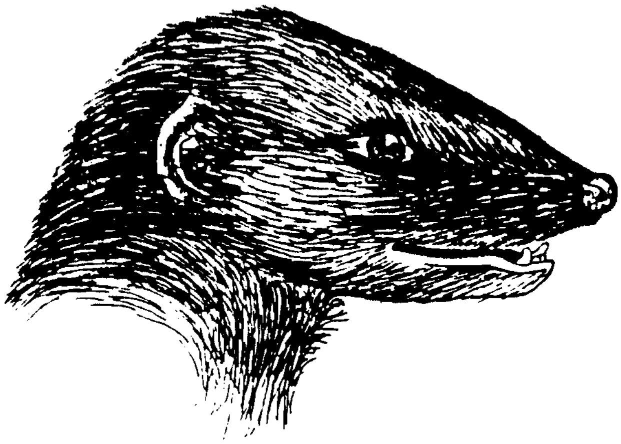
3. Grauer's Swamp Warbler (Bradypterus graueri). Vulnerable. Known only from a few highland swamps in Zaire, Uganda and Rwanda. In the Impenetrable, this warbler is only known to be present in Mubwindi Swamp (2,050 m). It is threatened by the drainage of swamps over much of its very limited range. Strict protection of Mubwindi Swamp would do much to ensure the long-term survival of this bird.

Ornithologists have visited only a very small portion of the Impenetrable and have spent but a few months there. There are, undoubtedly, a number of bird species yet to be documented as occurring in this Reserve. This is probably particularly true of the more localized and little known species.

During this survey, Jan Kalina and I added the following nine species to the bird checklist for the Impenetrable Forest. It should be noted that these nine species have not been included in the preceding calculations.

Crested crane	<u>Balearica regulorum</u>
Gray-backed camaraoptera	<u>Cameroptera bevicaudata</u>
Black cuckoo-shrike	<u>Campephaga sulphurata</u>
Joyful greenbul (probable)	<u>Chlorocichla laetissima</u>
European hobby	<u>Falco subbuteo</u>
Brown-headed parrot (probable)	<u>Poicephalus cryptoxanthus</u>
Harrier hawk	<u>Polyboroides typus</u>
Grey parrot	<u>Psittacus erithacus</u>
Buff-spotted crake (heard only)	<u>Sarothrura elegans</u>

In conclusion, the Impenetrable represents one of the most important avifaunal areas in Africa. Particular consideration should be given to the conservation of this avifauna because of its high and unique diversity of species, its exceptional scientific value, and its considerable potential for attracting tourists.



". . . to what extent does the present generation have the right to make critical decisions which will have an irreversible impact on future generations of humans? Do we have the right to decide for those not yet born that they must live in an environment overloaded with toxic nuclear and chemical wastes? Can we consciously leave behind only a small proportion of the species now living on Earth? Will King Kong and a few wildlife films adequately convey what was the mountain gorilla? If such is our legacy to future generations, then we should not expect to be remembered kindly." (Weber, 1981)

5. RECOMMENDATIONS FOR IMPROVING THE CONSERVATION AND MANAGEMENT OF THE IMPENETRABLE FOREST

5.1 PREVIOUS RECOMMENDATIONS

5.1.1 BACKGROUND

For at least the last forty years there has been constant pressure by various interest groups to exploit the Impenetrable Forest. Perhaps because of these pressures, together with long-term economic and political difficulties within Uganda, Forest Department and Game Department have not been responsive to previous recommendations to manage the Impenetrable Forest primarily as a conservation area and only secondarily for exploitation (Harcourt, 1981; Leggat and Osmaston, 1961). These earlier recommendations are briefly reviewed here.

5.1.2 RECOMMENDATIONS FROM THE WORKING PLAN

In the last Working Plan for the Impenetrable Central Forest Reserve (Leggat and Osmaston, 1961), it is stated that,

> The objects of management are:
>
> (a) to preserve the forest cover in the optimum state necessary to sustain stream flow, prevent soil erosion and maintain favorable climatic conditions;
> (b) to preserve habitat conditions favorable to the mountain gorilla;
> (c) to produce the maximum economic sustained yield of timber, subject to (a) and (b).

Based on the findings of Harcourt (1981) and those of the present survey, it is clear that these objectives have not been met.

5.1.3 RECOMMENDATIONS FROM THE LAST GORILLA SURVEY

In 1979, Dr. A. H. Harcourt of Cambridge University undertook a survey of the gorilla population in the Impenetrable Forest. Upon completion of his survey, he made the following five recommendations to the Ugandan Government (Harcourt, 1981):

1. ". . . if continued exploitation of the forest is to be allowed, the area used by gold-prospectors, hunters and loggers must be considerably reduced if the gorillas are to survive. All human use of the Reserve should therefore be strictly confined to the present area of the coupes, in effect making the remaining 85 percent of the southern section, where the gorillas occur, into a 217 km^2 Nature Reserve."

2. "Furthermore, any logging allowed should, as J. T. Emlen recommended after his survey of the Reserve in 1959/60 with G. B. Schaller, 'be restricted to one or two carefully circumscribed sectors at a time--these sectors to be shifted at intervals of not less than a year or two on a basis which would allow the gorillas to adjust to the disturbances' (Appendix C to Leggat and Osmaston, 1961)."

3. ". . . the success of a management plan allowing partial use of a conservation area depends on maintenance of very tight control over exploitation. In the case of the Bwindi Forest, this is not being provided at present and will always be difficult to ensure. The Ugandan Government should give serious consideration to gazetting the whole Bwindi Forest as a National Park or Nature Reserve."

4. "If the Bwindi Forest's immensely rich community of plants and animals is to be conserved, no further roads should be built into the Reserve."

5. "Both for the sake of gorilla conservation and for protection of water catchment areas, the remnants of forest along the border with Zaire to the north of the west end of the Bwindi Forest should be gazetted into the Reserve."

None of the above five recommendations by Harcourt have been implemented nor, as far as I am aware, considered for implementation.

5.2 RECOMMENDATIONS OF THIS REPORT TO UGANDA NATIONAL PARKS, FOREST DEPARTMENT AND GAME DEPARTMENT

5.2.1 INTRODUCTION

A number of recommendations are made here to help ensure the long-term protection and conservation of the Impenetrable Forest. They warrant serious consideration by National Parks, Forest Department, Game Department and other government bodies and people concerned with the protection and management of the Impenetrable Forest. During the formulation of these recommendations, the objectives of the Proposal for a National Conservation Strategy for Uganda (1983) were given strong consideration.

5.2.2 RECOMMENDATION ONE: THE ENTIRE IMPENETRABLE CENTRAL FOREST RESERVE SHOULD BE DESIGNATED A NATIONAL PARK

This is the single most important recommendation of this report. It is a recommendation that was first put forth in 1971 by National Parks but, unfortunately, never acted upon (see, New National Parks and Additionals to Existing Ones, 1971).

Ugandans with an awareness and appreciation of the distribution, status and importance of the Country's natural wealth have long considered that the Impenetrable Forest should be Uganda's next national park. National Parks, Forest Department, Game Department, and all people concerned with the long-term conservation of the Impenetrable Forest, should raise this issue again and encourage Government to gazette the whole Impenetrable Central Forest Reserve as a National Park.

5.2.2.1 TROPICAL MOIST FORESTS, NATIONAL PARKS AND UGANDA

> "Conserve adequate habitat is the basic dictum. If this simple plan is followed, the future existence of rain forest animals and plants is assured, and rain forest will continue to help sustain and enrich the life of man. The habitat is conserved if sufficient and representative samples of virgin tropical rain forest be set aside as national parks, inviolate in perpetuity." (Whitmore, 1975)

The most effective way to safeguard species and genetic resources in the wild is through the establishment of a network of national parks. Just over 1 percent of the land in the world has been set aside in national parks. However, not only is the area covered by national parks much too small, it is not representative of the earth's terrestrial ecosystems (Myers, 1979).

Tropical moist forests are in special need of additional parks. Almost half of the unrepresented or underrepresented biogeographic provinces occur in this biome. Listed among these are the "East African relict montane forests" (Myers, 1980), of which the Impenetrable is one of the more important examples.

Myers (1979, 1980) estimates that "at least 10 percent and perhaps as much as 20 percent of tropical moist forests need to be preserved, in select localities covering distinct ecosystems, in order to ensure preservation of sample biotic communities." In Africa less than 3 percent of the tropical moist forest is now in national parks and virtually all of this is in Zaire.

> "The historical phase of reserve establishment is all but over in the tropics (Amazonia being the only major exception). By the year 2000 $\pm$ ten years, there will be very little natural habitat left to preserve that is not already protected."
> (Whitmore, 1980)

In other words, the time for the acquisition of new national parks has almost ended. Within the next ten to twenty years, most countries will lose all options for establishing national parks in areas of critical importance for the future welfare of their citizens.

Will Uganda be among those countries which takes advantage of what little time remains and establish its own national parks in the tropical moist forest biome? Peru plans to protect 650,000 km^2 of tropical rain forest, Brazil 175,000 km^2, Indonesia 100,000 km^2, and Zaire 351,000 km^2 (Myers, 1979). None of these are wealthy countries, but all are aware of the long-term contributions that conservation of the tropical moist forest will make to future generations of their peoples. In light of these conservation activities by other less developed countries, it is certain that Uganda is today in a position to set aside some of its remaining 5,000 km^2 of tropical moist forest as national park.

Today's Uganda retains but a few areas which might be considered appropriate for inclusion into its national parks system; that is, unique natural areas which have not been irrepairably damaged by human activities and which, once set aside, are large enough to protect the plant and animal communities found therein, as well as the supporting physical environment. The Impenetrable Forest is premiere among these areas.

The establishment of an "Impenetrable Forest National Park" would reduce the area of Uganda's present Forest Reserve system (c. 16,000 km^2) by only 321 km^2, or just 2 percent. On the other hand, the addition of this forest to the existing system of national parks would be of incalculable significance to Uganda and ensure the long-term survival of this national heritage.

> "The establishment of a network of forest national parks throughout tropical Africa can be seen to be essential from a conservation viewpoint and also demonstrates the enlightened self-interest of the countries concerned." (Gartlan, 1974)

5.2.2.2 RATIONALE FOR AN "IMPENETRABLE FOREST NATIONAL PARK"

The following are some of the more important reasons why the entire Impenetrable Central Forest Reserve should be gazetted as a national park at this time.

A. Gazetting the Impenetrable Forest as a National Park Will Aid Development and Help Achieve the Proposed Goals of the National Conservation Strategy.

The Government of Uganda is revitalizing its devastated economy. A National Conservation Strategy, modeled after the World Conservation Strategy and designed to integrate conservation and development, has been proposed to make the most effective use of the Nation's remaining natural resources (see Section 1.4).

Designating the Impenetrable Forest as a national park is in line with the proposed goals of the National Conservation Strategy. Steps to establish a new national park as significant as the Impenetrable Forest would be an impressive and proper initial undertaking by those responsible for the formulation and implementation of Uganda's National Conservation Strategy.

B. Creation of a National Park Will Do Much to Overcome Present Conservation Problems in the Impenetrable Forest and Will Ensure its Survival.

a. As a national park, the Impenetrable Forest will remain in a natural state and provide benefits to Uganda.

The most important consideration at the present time is that neither Forest Department nor Game Department has policies or funds which make them capable of the intensive protection and management the Impenetrable Forest now requires if its conservation values are not to be further undermined and reduced. I do not wish here to be critical of either Forest Department or Game Department. The performance by both Departments in protecting and managing the Impenetrable Forest under the adverse conditions of the past decade bespeaks of a high level of resourcefulness and dedication. Nonetheless, I do wish to advocate that not enough is being done to conserve the Impenetrable Forest, and that it is now essential that stewardship of this precious resource be placed into the hands of National Parks and its Board of Trustees. If the Impenetrable Forest is to make its maximum sustained contribution to the economic, cultural and spiritual benefit of the people of Uganda, we must ensure its survival as best we can. National Parks are established precisely for this purpose.

As a national park, the Impenetrable Forest would be established as an inviolate area which is to exist in its natural state for all time. As a Forest

Reserve, the Impenetrable Forest can be logged, grazed, cultivated, planted with exotic trees, or, on the power of the Minister, degazetted.

> "One question which will have to be answered is who should manage Uganda's natural forest areas. At present all forests, natural or planted, come under the control of the Forestry Department whose main function is their economic exploitation--a role totally at odds with the conservation of natural forest. Ideally, some areas of natural forest should be made national reserves managed independently of the Forest Department." (Malpas, 1981)

b. <u>As a national park, the Impenetrable Forest will be administered by a board of trustees, not by one person</u>.

The National Parks Board of Trustees is comprised of highly qualified scientists, conservationists and administrators. As a Forest Reserve, the Impenetrable is ultimately under the control of one person.

c. <u>As a national park, the Impenetrable Forest will receive recognition and support from the international community</u>.

As a national park, the Impenetrable Forest will receive world-wide recognition as a place of exceptional significance to present and future generations of humanity. The international recognition Uganda will gain by the declaration of this new national park will, undoubtedly, be accompanied by considerable international support for its development, protection and scientific management. As a Forest Reserve, no such recognition will be forthcoming, and funds for the management and protection of the Impenetrable will continue to be scarce.

Largely because of its mountain gorillas, wealth of plant and animals species, and importance to Uganda's development, several international conservation organizations consider the Impenetrable Forest to be one of the most critical natural areas in Africa and have expressed considerable interest in supporting the development of this proposed park. For example, the World Wildlife Fund has already indicated that it would consider providing an initial grant to help purchase equipment for National Parks personnel in the Impenetrable. Among other potential supporting organizations are the New York Zoological Society, Frankfurt Zoological Society, African Wildlife Foundation, Fauna and Flora Preservation Society, EEC, USAID, UNESCO, UNEP, and UNDP.

". . . the conservation of biological diversity and genetic resources is a global problem, and there is a high degree of donor interest in this area. For example, the United States passed a law in November 1983 requiring that policy goals and practical steps be established for promoting the conservation and management of biological diversity in its foreign assistance programs. This effort will span development disciplines and sectors, including environment. . ." (Endangered Resources for Development, 1984)

d. As a national park, the flora and fauna of the Impenetrable Forest will receive maximum protection and scientific management.

As a national park, the Impenetrable Forest will be provided with the highest degree of protection and scientific management. This is especially important at this time for the remaining large mammals of the area. As a Forest Reserve, the Impenetrable has witnessed the extinction of buffalo and perhaps leopard, and the present near extinction of mountain gorilla, elephant, bushbuck and giant forest hog.

e. As a national park, the Impenetrable Forest can benefit Uganda through tourism.

As a national park, the Impenetrable Forest can be developed for tourism, and Uganda will benefit both by the recognition and foreign exchange that tourism generates (Appendix A). The Impenetrable presents a number of unique and interesting attractions to tourists. These include mountain gorillas and other primates, exceptional mountain scenery, comfortable climate, and a rich array of montane and lowland forest flora and fauna. In this regard, it is important to note that Uganda is the only Anglophone country offering tourists the opportunity to view gorillas.

Harcourt (1981) also recommended that increased tourism in the Impenetrable be given strong consideration by the Ugandan Government,

"The Kahuzi-Biega National Park in Zaire has shown that gorillas can be an important and lucrative tourist attraction, even in dense forest. Given that the annual revenue from the [Impenetrable Forest] Reserve is small compared with that from the Forest Department's exotic softwood plantations, it might well pay the Government to exploit the existing facilities of the Reserve for tourism rather than for timber."

Tourism, centered on viewing gorillas, has been equally successful in the Parc National des Volcans in Rwanda. This park has a particularly well operated and controlled tourist industry. In 1983 it charged each foreign visitor 45 U.S. dollars for park entry, plus one trip to see the gorillas. Well over 4,100 people (both local and foreign) entered this park in 1983, the the total direct revenue was more than $110,000 (Wilson, pers. comm.). In 1980, gross foreign revenue receipts directly attributable to tourism in the Parc National des Volcans was nearly $1 million, while the indirect contribution may have exceeded $3 million (Weber, 1981). Tourist numbers and revenues continue to rise rapidly as the demand for viewing the mountain gorilla continues to increase (Wilson, pers. comm.).

C. The Impenetrable Forest is a Unique Biological and National Treasure of Special Cultural and Economic Significance for the People of Uganda.

a. The Impenetrable Forest contains the endangered mountain gorilla.

The Impenetrable Forest is the home of about one-third of the world's population of 300 to 400 mountain gorillas (Section 4.3.2.6). The other two-thirds is located in the Virunga Volcanoes area and is protected in Zaire's Parc National des Virunga-Sud and in Rwanda's Parc National des Volcans. As one of only two sites in the world where this rare and endangered sub-species occurs, the international community is anxious to see that Uganda takes great care and effort to ensure the long-term survival of this animal.

b. The Impenetrable Forest represents a forest-type which is poorly represented in Uganda's system of national parks.

Only 2 to 3 percent of Uganda's land surface remains covered with tropical moist forest (Section 1.3.3). The Impenetrable Forest is a tropical moist forest and is thus representative of a biome which is being rapidly destroyed throughout East Africa and which is poorly represented in Uganda's existing system of national parks.

c. The Impenetrable Forest is a species-rich area.

For its size, the Impenetrable Forest is perhaps the richest area in East Africa in terms of plants and animals. In addition, it harbors a number of rare and endangered species and numerous species not found elsewhere in East Africa (Section 4). It is thus an important storehouse of genetic wealth and potential knowledge from which Ugandans and all peoples will continue to benefit (Appendix A).

d. The Impenetrable Forest includes Lowland, Transitional and Montane Forest types in a continuum.

The Impenetrable Forest is the only forest in East Africa, and one of the few in Africa, where contiguous forest vegetation extends from 1,160 to 2,600 m. This makes it a critically important watershed (Section 2.4.4), as well as an area of outstanding ecological diversity, scientific interest and scenic beauty.

e. The Impenetrable Forest represents a last opportunity for Uganda.

At 321 km^2, the Impenetrable Forest is, by far, the largest tract of natural forest in south-west Uganda (Figure 1). It, therefore, represents the last opportunity to conserve a sample of the vegetation type which once covered nearly all of Kigezi District and which, for reasons mentioned above, is unique in East Africa.

D. People Living in the Vicinity of the Impenetrable Forest will Benefit if it Becomes a National Park.

The people of Uganda will benefit considerably from the contributions of the Impenetrable Forest to their economic, cultural and spiritual well-being. Appendix A outlines in detail some of the benefits to be derived from tropical moist forests. The people in the immediate vicinity of the Impenetrable Forest will be most affected by its change of status to a national park. The following are some of the benefits to be incurred by present and future generations of people living in the vicinity of the Impenetrable Forest.

1. The most important water catchment in the region will be protected from further degradation (Sections 1.4.4, Appendix A).

2. Rainfall in the region will not decrease as would be expected should the Impenetrable be destroyed (Appendix A).

3. There will be training and new jobs associated with management and protection of the national park, and with tourism.

4. Activities to protect this park are also expected to lead to several major conservation efforts in the surrounding areas; most notably reafforestation, agroforestry, soil and water conservation, family planning and increased interest in conservation.

5. Forests once covered most of south-western Uganda. Thus, forests have played an important part in the traditions and cultures of the people of this region. As the only remaining natural forest in the area, the Impenetrable will continue to be a source of pride and an important cultural, emotional and spiritual link to the past.

5.2.3 RECOMMENDATION TWO: FIVE ADDITIONAL AREAS SHOULD BE GAZETTED TO THE IMPENETRABLE FOREST

5.2.3.1 BACKGROUND

Appendix E states that the primary goal of most conservation areas is to maximize the number of species contained therein and to sustain these species for all time. Appendix E also presents five basic principles from ecology and genetics which I have used as guidelines in formulating the following recommendations for changes in the design of the Impenetrable Forest Reserve. From Appendix E, the reader will obtain a better understanding of the logic behind the recommendations made below and a greater appreciation for the need to implement these recommendations.

Among people charged with designing national parks and reserves, there is considerable agreement that the most important principle to follow is that protected areas always be as large as possible. In this context, it is important to point out that the average size of the world's national parks is over 2,000 km^2 and that there are at least thirty-two national parks which are more than 10,000 km^2 in area. Thus, at 321 km^2, the Impenetrable Forest is a relatively small area. This unfortunate situation cannot be readily ameliorated to any great extent since little suitable undisturbed forest exists outside of the present boundaries of the Forest Reserve. Some small, but highly significant additions of land can and should be made however.

5.2.3.2 COMPENSATION TO DISPLACED AGRICULTURALISTS

Recommendations to add land to the existing Reserve also require that all people be removed from such areas. In these cases, the people being displaced should be fairly compensated for all losses such resettlement might cause. People should not be required to leave any area until suitable alternative land is made available and until funds for their compensation are secured. While it is vital that additional areas be added to the Impenetrable Forest Reserve, it is equally important that all concerned be treated fairly and that good relationships be maintained in every case.

I recommend that, if possible, local government provide all displaced persons with new land as close to their former land as possible. Money for compensation can probably be secured from the international conservation community. The compensation to be paid should be agreed upon by officials from Local and Central Governments.

5.2.3.3 AREAS TO BE GAZETTED

A. Area One: Arusuru-Nuundu Ridge

The following recommendation was first made by Harcourt (1981) upon completion of his 1979 survey of the gorillas of the Impenetrable Forest.

> "Both for the sake of gorilla conservation and for protection of water catchment areas, the remnants of forest along the border with Zaire to the north of the west end of the Bwindi Forest should be gazetted into the Reserve. This area is, with the Bwindi Forest itself, part of the catchment area for the main river the Munyaga, in the region. The rapid deforestation that is occurring there could, therefore, easily have far-reaching detrimental effects to the north, particularly as the soils of the Bwindi region are susceptible to erosion if the vegetation cover is removed. . ."

Harcourt is referring to the "Arusuru-Nuundu Ridge," which lies to the north of Rushuura Hill on the north-west corner of the Reserve (Figure 12). This is the only tract of forest of substantial size which is outside of the present Reserve yet remains connected to it. The top and upper slopes of this ridge are covered with forest, but this is being rapidly destroyed at a number of places. There is considerable erosion where the vegetation is being removed and, as mentioned by Harcourt, this loss of soil into the drainage of the Munyaga River is causing considerable damage to the area.

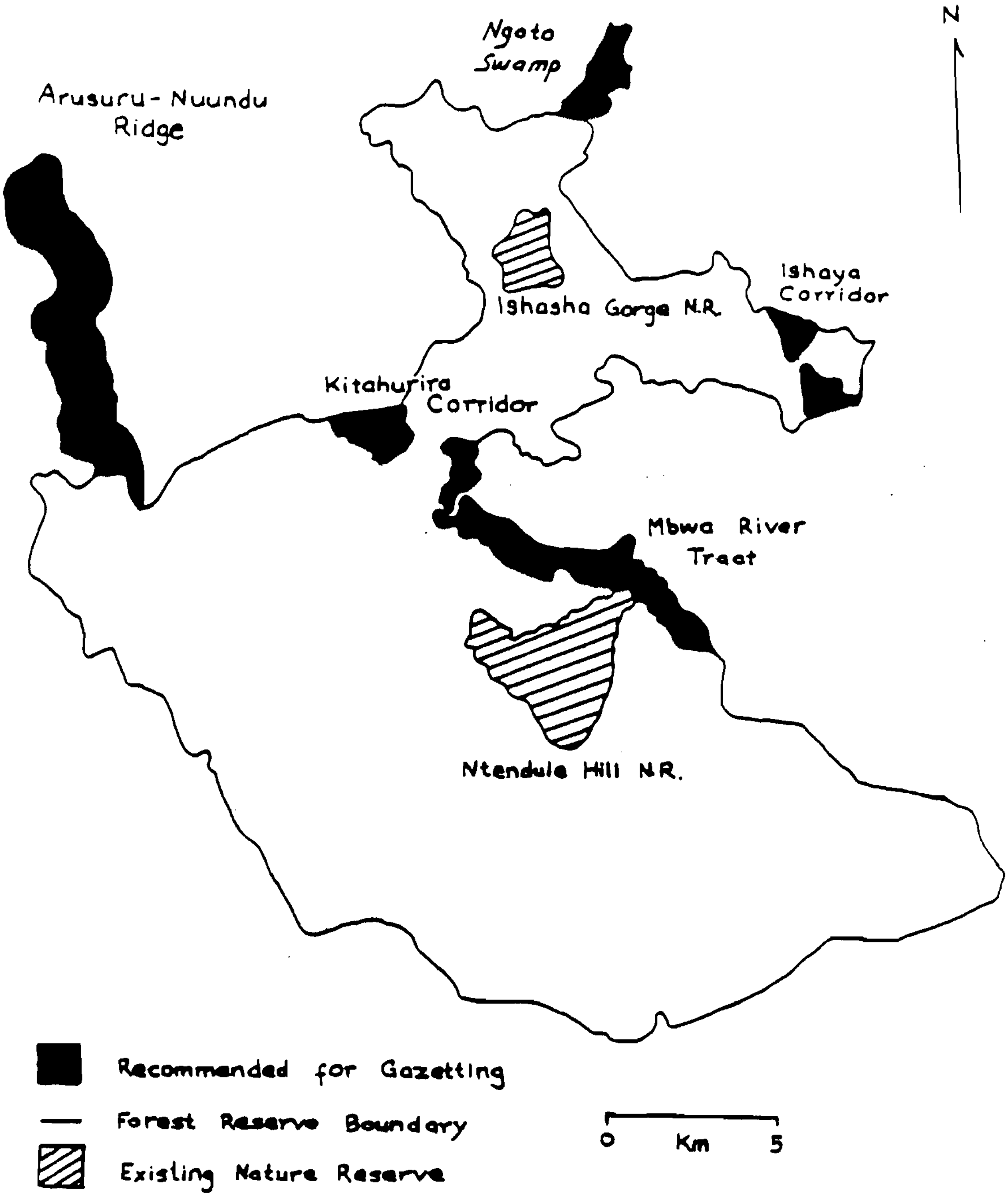


Figure 12. Areas recommended for gazetting to the Impenetrable Forest Reserve. The two nature reserves are also shown.

The number of gorillas using this area remains uncertain. Harcourt found one group of four animals here, but I believe that between ten and twenty are using this ridge. It is from this region that two gorillas were reportedly killed by villagers in 1981. Whatever the number of gorillas in this area, it represents the only place in the world where mountain gorillas exist outside the protective boundaries of a national park or reserve. Because there are so few mountain gorillas remaining, and so little habitat available, it is imperative that this area be placed within the boundaries of the Reserve.

The area proposed for inclusion runs for 10 km along the top of the Arusuru-Nuundu Ridge (Zaire-Uganda Border). That is, from Rushuura Hill to Nkabwa Hill. All of the land to the east and within 1.5 km of the top of this ridge should be included. The total area demarcated is 15 km^2 and is comprised mostly of primary and secondary forest with some grass-covered hilltops. About 18 km^2 of forests abuts this addition on the Zaire side of the ridge. The gazetting of this area to the Reserve requires that 10 km of boundary be opened and planted with exotic trees. I estimate that c. 15 percent of this area is under cultivation. About two to four families live here, but others enter this area to cultivate.

Addition of the Arusuru-Nuundu Ridge to the Impenetrable Forest Reserve will greatly enhance the conservation values of the Reserve. Specifically, it will accomplish the following:

1. The population of gorillas in the Reserve will be increased by ten to twenty animals. Their inclusion will mean that the entire world population of mountain gorillas are protected by national parks or reserves. While ten to twenty gorillas does not seem like a large number, it is, nonetheless, a very significant addition when one considers that it will increase the population of gorillas in the Impenetrable Forest by 9 to 17 percent.

2. The Arusuru-Nuundu Ridge lies between 1,400 and 1,900 m. It thus is covered largely by Transition Forest, the forest type most poorly represented in Uganda's Reserves.

3. The upper portions of the watersheds of the Nyamukozho, Nyabubare, Nyamutendere, Bururuma and Kesero Rivers will be protected. All five rivers empty into the important Munyaga River, which flows to Lake Edward.

4. Little is known about the flora and fauna of this area, but its relative aridity and its close proximity to the Rutshuru Plain in Zaire (2 to 3 km to the west) suggests that it may have a flora and fauna which differs in important respects from that of the body of the Impenetrable.

5. Inclusion of this area will increase the size of the Reserve by 15 km^2, or nearly 5 percent.

B. <u>Area Two: Kitahurira Corridor</u>

One of the principles for the design of reserves is that corridors of suitable habitat be established wherever possible (Appendix E). To function properly, such corridors must be wide enough to ensure:

1. that they provide a variety of habitat types;

2. that they are readily used by both plants and animals;

3. that they do not "funnel" animals into narrow strips of habitat where they are easily disturbed or poached; and

4. that they are not readily dissected by human activities such as illegal encroachment.

There are two major corridors in the Impenetrable. Recommendations 2 and 3 are concerned with the widening of these corridors.

The more important of the corridors is located at Kitahurira and connects the North Sector with the South Sector of the Impenetrable. The "Kitahurira Corridor" is now about 2 km long and 1 km wide (Figure 12). At one point, this corridor consists largely of grassland, making the effective habitat along which forest species can move only 0.5 km wide. Vehicle travel along the road here is light, but sixty to one hundred twenty people walk it each day (Section 3.11.3). The land just outside of the Reserve has been settled by agriculturalists.

Harcourt (1981) made special mention of this narrow strip of forest and the adverse effect that the road is having on gorillas,

"It seems likely that the absence of gorillas from the northern offshoot of the Reserve is due, at least in part, to the intensive human use of the region and especially of the narrow neck of land joining the northern offshoot to the rest of the Bwindi Forest."

I also believe that the heavy human use of the North Sector, in combination with the present narrow corridor connecting the North and South Sectors, are responsible for the absence of a number of mammals from the North Sector, most notably gorilla and elephant.

I recommend that two tracts of land be added to the Reserve to widen the Kitahurira Corridor. One tract is located on either side of the corridor.

The first tract includes the area occupied by Kitahurira, Kitwa Hill and Rwenkuba Hill. It is bordered on the east and south-east by the road which goes to Karambi, on the east by the Kinyambeho River, on the north-west by the present Reserve boundary, and on the south by the road that runs from Ruhizha to Kayonza.

There is little forest in this area, most of it having been cleared for agriculture. The total area of this tract is about 1.5 km^2, and it varies in elevation from 1,550 to 1,740 m. About two families live on Kitwa Hill and about three families on Rwenkuba Hill. The remainder of the area holds about five to seven families. No new boundaries are required, as these are demarcated by a river and two roads.

The second tract includes all of the land between the present reserve boundary and a line running from the top of Kashekyera Hill on the Reserve boundary, north-east to the top of Mushorero Hill and continuing north-east to meet the Reserve boundary at the point where the Kitahurira-Kayonza Road no longer constitutes the west boundary of the Reserve.

This area covers approximately 2.5 km^2 and ranges in elevation from 1,525 to 1,740 m. Nearly all of the forest has been removed for cultivation. About nine families live in this area. Approximately 2.5 km of new boundaries must be opened and planted with exotic trees in order to demarcate this addition.

Implementation of this recommendation will do much to improve the design of the Impenetrable Forest and secure the long-term conservation values of the area. The following will be accomplished by the inclusion of these two small tracts into the Reserve:

1. The width of the Kitahurira Corridor will increase from 1 km to 2.5 km, and the total area covered by the corridor will change from

2.5 km^2 to 6.5 km^2. Making this corridor wider should considerably enhance the exchange of individuals and genes between the North and South Sectors of the Impenetrable Forest. This corridor will encourage gorillas, elephants and other species to move into the North Sector and make use of this portion of the Reserve.

2. The increased size of the Kitahurira Corridor will serve as a buffer against the effects of illegal encroachment into this vital area. It will, therefore, do much to help ensure that the important distinction that the Impenetrable Forest now holds as the ". . . only one in East Africa that contains both montane and lowland forest in a continuum." (Keith et al., 1969) is not shattered by the loss of this corridor to agriculture.

3. Since the Kitahurira Corridor lies between 1,500 and 1,740 m, it is at the elevation of the Transition Type Forest. As mentioned earlier, the area in Africa covered by Transition forest has been greatly reduced as a result of agriculture. The few remaining areas are, therefore, in great need of protection. The addition of these two tracts of land to the Kitahurira Corridor will add 4 km^2 of Transition Type forest to the Reserve and increase the size of the Reserve by about 1 percent.

4. The erosion of soil on these 4 km^2 will be considerably reduced, and the watersheds of the upper portions of the Kahororo River and two lesser rivers flowing into the Ihihizo River will be protected.

C. Area Three: Ishaya Corridor

The second corridor in great need of enlargement lies at the junction of the Ishasha and Ishaya Rivers in the extreme eastern portion of the North Sector. The 2 km^2 tract of forest here is joined to the main part of the North Sector by a strip of forest only about 200 m wide, the "Ishaya Corridor" (Figure 12). The 2 km^2 tract is, therefore, in grave danger of becoming excised from the Reserve as agriculturalists continue to clear land along the Ishaya Corridor. To prevent this from occurring, it is necessary to widen this Corridor.

The Ishaya Corridor should be widened by adding two tracts of land to the Reserve. The first tract lies between the present south boundary of the Reserve and a new boundary cut from Boundary Marker 58 west north-west to where the Bugoro and Kasinga Rivers join the Ishasha River. The second tract lies between the present north boundary of the Reserve and a new boundary cut between Boundary Markers 78 and 95.

These two tracts have been largely cleared of forest. They lie at elevations between 1,370 and 1,800 m and total 1.5 km^2. About seven families now occupy these two tracts of land.

The addition of these two areas will widen the Ishaya Corridor from 0.2 km to 2.5 km and add 1.5 km^2 to the Reserve. This will result in greater protection of the 2 km^2 of forest to the east of this corridor and permit greater movement of plants and animals between this area and the main block of the North Sector.

No inventories of the flora and fauna of this area have been undertaken. However, its proximity to the Ishasha Gorge makes it likely that it supports part of the populations of several species of trees not found elsewhere in East Africa (Section 4.2).

About 1.4 km of the east side of the Ishasha Gorge and 2 km of the south valley of the Ishaya River will receive protection from erosion and further deforestation. The 1.5 km^2 of land added to the Reserve is expected to be recolonized by trees and resort back to the valuable Transitional Type forest.

D. Area Four: Mbwa River Tract

The Mbwa River serves as the boundary to the Reserve for a distance of about 10 km along the north-east edge of the South Sector. Running more or less parallel, and from 0.3 to 1.0 km to the north of the Mbwa River is the road from Rubanda to Kitahurira. I recommend that all of the land between this road and the Mbwa River, from near Bitanwa at the south end to Kitahurira at the north end, be made part of the Reserve (Figure 12).

The total area of the "Mbwa River Tract" is about 9 km^2. It ranges in elevation from 1,550 m near Kitahurira to 2,250 m near Bitanwa. I estimate that about 40 percent of this area is still covered with forest, and some of this forest is in large patches, especially in the valley bottoms. Considerable numbers of mahogany are still present. The long, often steep slopes of the Mbwa River Tract make it highly susceptible to erosion, and it appears to be a major source of the siltation seen in the Mbwa River. The present road will serve as the new boundary.

Forest Department has already taken some steps to incorporate the Mbwa River Tract into the Reserve. In January, 1983, Forest Department removed about eight families from the southern 4 km^2 of this tract (the Nyakashunzu Area). Forest Department is encouraged to continue with its plan to secure the remaining 5 km^2 of the Mbwa River Tract. The Zonal Forest Officer in Kabale has indicated that sixty-eight families remain in this area.

Addition of the Mbwa River Tract to the Reserve will do the following to enhance the design and conservation values of the Impenetrable Forest:

1. This is an area which gorillas favored in the past and where most previous visitors to the Impenetrable came to observe gorillas. Because of its accessibility by road from Ruhizha (just 4 km to the south-east), this is the most suitable area in the Impenetrable Forest for the development of tourism based on gorilla viewing. With the removal of the people from the Nyakashunzu Area in January, 1983, the gorillas are again frequenting this area. The Mbwa River Tract is once again the place where most tourists see gorillas. The Game Guard who guides tourists to these gorillas says that the main group of gorillas here consists of about eighteen individuals. In addition to gorillas, this is also a good area in which to view black-and-white colobus and blue monkeys.

2. The Mbwa River Tract covers an area of about 9 km^2. The addition of this area will increase the size of the Reserve by approximately 3 percent. Because of the many remaining patches of forest here, it is expected that the area will recover rapidly from the effects of deforestation and eventually be covered once again with Transitional and Montane Forest.

3. The addition of this tract will place virtually the entire watershed of the Mbwa River within the boundaries of the Reserve. The reduced erosion that this will bring about should greatly improve the quality of water in the Mbwa River. The Mbwa River is a main tributary to the Ishasha River which flows to Lake Edward.

4. Moving the Reserve boundary from the Mbwa River to the Rubanda-Kitahurira Road will make law enforcement activities much more efficient, since roads are easier to patrol than are steep river valleys far from roads.

E. Area Five: Ngoto Swamp

As indicated in Appendix E, "The most important goal for most national parks is the maximization of the number of species contained therein and the sustained maintenance of these species." This last recommendation is concerned primarily with adding a biotic area to the Reserve which is not already represented. Because this area has not been studied in detail, I cannot talk in exact terms about what it will contribute to the Reserve. Nonetheless, it is so different from areas represented in the present Reserve that there can be no doubt that it harbors many species of plants and animals not now found within the boundaries of the Impenetrable Forest.

At present, Mubwindi Swamp, which lies at 2,070 m, is the only sizeable swamp in the Reserve (c. 1 km^2). Ngoto Swamp is located on the north-east corner of the North Sector. It is the only swamp close enough to the forest to be considered for inclusion into the Reserve.

I recommend that the entire Ngoto Swamp, plus a 100 m wide perimeter around this swamp, be added to the Reserve. The total area is about 1 km^2. About 5 km of boundary will have to be cut and planted with exotics. There are probably no people living within this area.

At 1,280 m, Ngoto Swamp is 800 m lower than Mubwindi Swamp and thus has a very different vegetation cover and, presumably, also a very different fauna. An additional major consideration is that Ngoto Swamp receives drainage from the Kinyampimbi, Kiiga, Kabashaki and several other rivers. Failure to protect the Ngoto Swamp would have adverse effects on the availability of water in the area.

5.2.4 RECOMMENDATION THREE: A PERMANENT RESEARCH STATION SHOULD BE ESTABLISHED AND AN INTENSE PROGRAM OF APPLIED RESEARCH UNDERTAKEN ON THE ECOSYSTEM, FLORA AND FAUNA OF THE IMPENETRABLE FOREST

5.2.4.1 BACKGROUND

Almost no data are available on the ecosystem of the Impenetrable Forest. What data we have were obtained primarily during several short-term surveys and collecting expeditions in the 1960's. This inadequate data base is a major impediment to rational decision making, and thus to the development of a sound policy for the utilization, management and conservation of this forest. A permanent research station is necessary to initiate, integrate, coordinate and support an active program of applied ecological research in the Impenetrable Forest.

At this time there is only one research station conducting ecological studies in Uganda's rain forests. This is the Kibale Forest Project's research station, which is supported primarily by the New York Zoological Society. The Kibale Forest is a medium altitude rain forest lying about 200 km north north-east of the Impenetrable. It, thus, differs considerably from the Impenetrable in its flora and fauna. A field station in the Impenetrable would yield not only comparative data on medium altitude forest, but also information on lowland and montane forest types . .. two forest types not found in Kibale and, as yet, little studied in East Africa.

5.2.4.2 THE GOAL

The overall goal of this research station should be to secure the highest possible conservation values for the flora, fauna, and watershed of the Impenetrable Forest. To achieve this goal, the research station must:

1. Assist in the establishment of an effective management and conservation policy for the Impenetrable and in incorporating this policy into Uganda's National Conservation Strategy.

2. Assist in establishing a body of well-trained manpower capable of administering, coordinating and conducting effective research, conservation and management in the Impenetrable.

3. Conduct field research designed to answer critical management and conservation questions.

4. Secure moneys necessary for research, education, training and the implementation of conservation practices in the Impenetrable and its environs.

5.2.4.3 RESEARCH PRIORITIES

As applies directly to research, this station should be concerned primarily with promoting and conducting studies which are highly applicable to the improved conservation of the Impenetrable and its environs.

In particular, there are two initial priorities for research in the Impenetrable Forest.

1. An updated, more complete and more detailed inventory of the resources and biological values

of the Impenetrable Forest must be undertaken. Such an inventory would lay the foundation for the long-term, integrated study and monitoring of the resources of this area. The bamboo zone (Section 3.4.3) and Mubwindi Swamp (Butynski, 1984) should be given particular attention.

2. An extensive body of data are needed on the gorilla population, and on the effects of man's activities on this species (Section 4.3.2.6). This data would be used to design a management plan for the enhanced conservation of this population of gorillas. Specifically, research is needed to:

    a. Accurately assess the number, distribution and population structure of the gorillas. This would represent the beginning of a long-term program for monitoring the dynamics of this population and for determining its habitat requirements.

    b. Evaluate the effects of various human activities on the behavior, ecology, distribution and survival of gorillas.

5.3 RECOMMENDATIONS OF THIS REPORT SPECIFIC TO GAME DEPARTMENT

5.3.1 RECOMMENDATION 1. THE GAME ACT SHOULD BE REVISED AND UPDATED TO TAKE ACCOUNT OF THE CHANGES UGANDA HAS UNDERGONE SINCE 1964. Special consideration should be given to the following:

1. Fines and prison terms for violating the Game Act should be greatly increased so that the punishment serves as a deterrent to the crime (Section 3.2).

2. Forest Guards should be authorized to enforce the Game Act (Section 3.2).

5.3.2 RECOMMENDATION 2. GAME DEPARTMENT SHOULD TAKE STEPS, TOGETHER WITH MINES DEPARTMENT, FOREST DEPARTMENT, POLICE AND LOCAL GOVERNMENT TO PUT A STOP TO THE RAMPANT ILLEGAL MINING IN THE IMPENETRABLE FOREST ANIMAL SANCTUARY (Section 3.7).

5.3.3 RECOMMENDATION 3. GAME WARDEN OR OTHER SENIOR GAME DEPARTMENT OFFICER SHOULD BE ASSIGNED TO THE IMPENETRABLE FOREST TO ADMINISTER THIS ANIMAL SANCTUARY AND, PARTICULARLY, TO COORDINATE AND SUPERVISE THE ACTIVITIES OF THE GAME GUARDS. Such a person is needed if the current high rate of poaching in this forest is to be curtailed (Section 3.6.2).

5.3.4 RECOMMENDATION 4. THE NUMBER OF GAME GUARDS SHOULD BE INCREASED TO FIFTEEN. At present, there are too few Game Guards to deal effectively with the severe poaching problem in the Impenetrable (Section 3.6.2). Three Game Guards should be placed at each of the following five locations: Ruhizha Area, Kitahurira Area, Kayonza Area, Rushaga Area, Buhoma Area.

5.3.5 RECOMMENDATION 5. GAME GUARDS SHOULD EFFECTIVELY PATROL ALL AREAS OF THE IMPENETRABLE FOREST. Game Guards are not patrolling regularly, and there are many areas of the Impenetrable Forest which they seldom, if ever, visit. The harder-to-reach sections of this forest can only be visited if Guards spend one to two nights in the forest . . . this is seldom done. Guards, therefore, need to be given direct instructions as to what patrol schedule they must follow each week. Checks by the senior officer must be made to see that these schedules are followed and that the Guards are being effective.

5.3.6 RECOMMENDATION 6. ALL GAME DEPARTMENT PERSONNEL SHOULD BE GIVEN SALARY INCREASES SO THAT THERE WILL BE SUFFICIENT INCENTIVE TO CONDUCT THEIR DUTIES EFFECTIVELY AND ON A FULL-TIME BASIS (Section 3.2).

5.3.7 RECOMMENDATION 7. GAME DEPARTMENT STAFF NEEDS ADDITIONAL SUPPORT EQUIPMENT. Game Department should seek funds for the following materials:

1. one four-wheel drive vehicle for the senior Game Department official. This vehicle should be stationed in the Impenetrable.

2. one bicycle for each Game Guard.

3. two uniforms for each Game Guard.

4. boots, rain-gear, coats, blankets, tents and new rifles for all Game Guards.

5.3.8 RECOMMENDATION 8. GORILLA VIEWING BY TOURISTS MUST BE MORE STRICTLY REGULATED. Game Guards should adhere to the following three rules to help reduce harassment of gorillas and injuries to people:

1. The total number of people visiting a group of gorillas at any one time, inclusive of Game Guards, should not exceed six.

2. The "contact time" between visitors and gorillas should not exceed two hours.

3. If any gorilla is provoked into a charge, the visitors must leave immediately after the first charge.

5.4 RECOMMENDATIONS OF THIS REPORT SPECIFIC TO FOREST DEPARTMENT

5.4.1 RECOMMENDATION 1. THE FORESTS ACT (1964) AND WORKING PLAN FOR THE IMPENETRABLE CENTRAL FOREST RESERVE SHOULD BE ADHERED TO. The illegal removal of forest produce from the Impenetrable Forest is occurring on a large scale (Sections 3.4, 3.11.5 and 3.12). This is having adverse effects on the flora and fauna of the Reserve and represents a considerable loss of revenue to Government (Section 3.4.4.3). Most of this damage and loss could be brought to a stop if Forest Department were to once again ensure that those people using this Reserve strictly adhered to the Forests Act (1964) and the last Working Plan for the Impenetrable Central Forest Reserve (Leggat and Osmaston, 1961) (Section 3.4.4.5). As they apply to the Impenetrable Forest, the most important rules in The Forests Act are presented in Section 3.1.2 of this report, and the most significant prescriptions of the Working Plan are put forth in Section 3.1.1. In particular, the following rules and prescriptions should be given the utmost consideration:

From The Forests Act (1964):

1. That no forest produce be cut or removed without a permit.

2. That no forest produce be removed from the place it was cut or taken until checked and marked by a Forest Ranger or Forest Guard.

3. That all sawyers register a set of letter dies.

4. That each piece of timber cut by the sawyer be marked with his letter dies.

From the Working Plan:

1. That the coupe system be re-established.

2. That no forest produce be removed from nature reserves.

3. That reserve and nature reserve boundaries be maintained.

5.4.2 RECOMMENDATION 2. THE FORESTS ACT AND WORKING PLAN SHOULD BE REVISED AND UPDATED. Special consideration should be given to the following:

1. Penalties for violating The Forests Act need to be substantially increased. Fines and prison terms should be brought in line with the economic realities of today's Uganda, so that they truly serve as deterrents to illegal activities (Section 3.2).

2. All pit-sawn stumps should be individually numbered so that the actual quantity of trees felled on a particular license is controlled. The number would be in addition to the Forest Department symbol and the license number of the pit-saw operator as now required. This system would permit verification of field personnel reports and make it possible to detect felling violations and convict those responsible.

3. Game Guards should be authorized to uphold The Forests Act (Section 3.2).

5.4.3 RECOMMENDATION 3. FOREST DEPARTMENT SHOULD HALT ALL EXPLOITATION IN THE IMPENETRABLE CENTRAL FOREST RESERVE UNTIL SUCH EXPLOITATION CAN BE BROUGHT UNDER CONTROL AND MANAGED ON A SCIENTIFIC BASIS. At present, the following situation exists:

1. Approximately 90 percent of the people removing products from the Impenetrable are doing so illegally (Sections 3.4, 3.11.5 and 3.12).

2. There is no scientific basis for determining quotas for any of the products being removed from this Reserve.

3. Government is receiving but a small fraction of the revenue it is due.

5.4.4 RECOMMENDATION 4. THE BUHOMA-IVI RIVER ROAD SHOULD BE CLOSED TO ALL TRAFFIC UNTIL A FORMAL INVESTIGATION OF ITS LEGALITY HAS BEEN UNDERTAKEN AND UNTIL THE EFFECTS OF THIS ROAD ON THE IMPENETRABLE CENTRAL FOREST RESERVE CAN BE DETERMINED (Section 3.11.5).

5.4.5 RECOMMENDATION 5. IMPLEMENT HARCOURT'S (1981) SUGGESTION THAT "NO FURTHER ROADS SHOULD BE BUILT INTO THE RESERVE" (Section 3.11).

5.4.6 RECOMMENDATION 6. FOREST GUARDS AND PATROLMEN NEED MORE SUPERVISION FROM SENIOR FOREST DEPARTMENT STAFF TO ENSURE THAT ALL PORTIONS OF THE IMPENETRABLE CENTRAL FOREST RESERVE ARE BEING PATROLLED EFFECTIVELY. Among other things, this requires better scheduling and coordination of their activities as well as overnight camps in the forest.

5.4.7 RECOMMENDATION 7. A FOREST STATION SHOULD BE ESTABLISHED AT BUHOMA TO DEAL WITH MATTERS IN THE WESTERN HALF OF THE SOUTH SECTOR. This area has been badly neglected because of its considerable distance from the existing Forest Stations. With the placement of an additional Forester or Ranger at Buhoma, the number of senior staff in the Impenetrable should be adequate. Additional Forest Guards, Patrolmen and Forest Workers, however, are needed.

5.4.8 RECOMMENDATION 8. FOREST DEPARTMENT SHOULD WORK CLOSELY WITH MINES DEPARTMENT, GAME DEPARTMENT, POLICE AND LOCAL GOVERNMENT TO BRING AN END TO THE LARGE SCALE ILLEGAL MINING IN THE IMPENETRABLE CENTRAL FOREST RESERVE (Section 3.7).

5.4.9 RECOMMENDATION 9. FOREST DEPARTMENT SHOULD WORK CLOSELY WITH CUSTOMS, POLICE AND OTHER OFFICIALS TO STOP THE CONSIDERABLE ILLEGAL EXPORT OF LUMBER FROM THE IMPENETRABLE CENTRAL FOREST RESERVE TO RWANDA (Section 3.4.4.3).

5.4.10 RECOMMENDATION 10. ALL FOREST DEPARTMENT PERSONNEL SHOULD BE GIVEN SALARY INCREASES TO A LEVEL COMMENSURATE WITH THE DIFFICULTY AND IMPORTANCE OF THEIR

WORK. Such an incentive is imperative to the successful operation of this Department. At present, many jobs go undone as staff are forced to undertake other activities to subsidize inadequate salaries (Section 3.2).

5.4.11 RECOMMENDATION 11. FOREST DEPARTMENT STAFF IN THE IMPENETRABLE CENTRAL FOREST RESERVE NEEDS ADDITIONAL SUPPORT MATERIALS. It appears that, overall, the Forest Department staff is well trained to deal with the job at hand. Its effectiveness, is, however, greatly curtailed by a lack of equipment, particularly vehicles. Forest Department should seek funds for the following items:

1. one four-wheel drive vehicle to be stationed in the Reserve.
2. one motorbike for each Forester and Ranger.
3. one bicycle for each Forest Guard and Patrolman.
4. two uniforms for each Forest Guard and Patrolman.
5. boots, rain-gear, coats and blankets for all personnel.
6. new rifles and tents for all Forest Guards.

The above is a list of the most immediate needs. Further funds should be sought for construction and maintenance of buildings, for training and for additional support equipment.

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APPENDIX A

THE VALUES OF TROPICAL MOIST FORESTS (TMFs) TO MANKIND

INTRODUCTION

> "The world's tropical forests comprise vast, important ecosystems that are being lost and disturbed because of human attempts to obtain food, shelter, energy, and economic reward. As plant cover is reduced, social, economic, and ecological problems left in its wake pose great risks to millions of people in tropical areas. Moreover, opportunities to extract greater economic and social benefits from tropical forest resources are being forfeited because of inadequate knowledge and unwise management practices. To address the problems of tropical forests, the nature and character of this resource, its value to mankind, and the diverse stresses it is under must be understood."
>
> (The World's Tropical Forests, 1980)

Uganda is presently assessing its available natural resources and attempting to determine how various habitat types might be most wisely developed (see Proposal for a National Conservation Strategy for Uganda, 1983). People responsible for land use planning and policy decisions must be aware, however, that certain habitat types, such as TMFs, may already be providing maximum contributions to the long-term development of Uganda simply through the many free services they provide. In other words, conservation may, in itself, be a legitimate use of the resources of some areas. The maintenance of undisturbed natural land may well be as important to Uganda's development as farming, ranching, forestry or mining (World Conservation Strategy, 1980).

There is one vital point which Ugandans must always bear in mind when decisions are being made concerning trade-offs between preservation and destruction of their TMFs. This is that "extensive deforestation or land conversion is a undirectional process that can prohibit future efforts." (Oldfield, 1981). That is to say, once a TMF is destroyed, all its actual and potential present and future benefits to humanity are, for all practical purposes, lost forever.

> "The unidirectionality of the preservation-development continuum should encourage decision-makers to err on the side of conservation whenever development projects will entail irrevocable consequences." (Oldfield, 1981)

In evaluating how a tract of TMF can best benefit a nation or region, we must, obviously, be aware of both the current and potential benefits of the TMF. Typically, the benefits are divided into (1) those obtained as "free services" from the undamaged TMF ecosystem, and (2) those provided as a result of "exploitation" of the TMF. Some of the benefits, especially those involving exploitation, are obvious and well known. The free services tend to be more subtle and less widely recognized, but oftentimes most important . . . especially over the long-term.

Growing numbers of people believe that TMFs should be conserved because they are ancient, stable, self-sustaining ecosystems of great richness, complexity, interest and aesthetic beauty, and because man has a moral responsibility to other men, other cultures, other generations and other living entities such as the forest and its wildlife (Myers, 1979; Richards, 1973).

> "The ultimate reason for conservation, and the only one that cannot be compromised: [communities and species] should be conserved because they exist and have existed for a long time." (Ehrenfeld, 1976)

Although these ethical arguments are worthy, they are unlikely, in themselves, to lead to the conservation of much TMF. This is particularly true in the Lesser Developed Countries where natural resources such as wood, food and land are often in short supply. TMF conservation must, therefore, rely primarily on pragmatic and economic arguments . . . we must demonstrate both the short- and long-term utilitarian benefits that TMFs yield to humanity. Some of these are outlined in this Appendix.

FREE SERVICES WHICH UNEXPLOITED TROPICAL MOIST FORESTS PROVIDE TO MANKIND

TROPICAL MOIST FORESTS SERVE AS WATER CATCHMENT AREAS AND MINIMIZE SOIL EROSION AND DEGRADATION.

Clearing the TMF initiates a chain of degradation in the quality and quantity of water and soils of the area (Nicholson, 1936; Oldfield, 1981; Olet, 1977; Poore, 1976; Spears, 1982; World Conservation Strategy, 1980). Under the vegetative cover of the TMF:

1. water courses run clear and clean, and exhibit a regular, reliable flow throughout the year;

2. erosion and leaching are minimal, and soils are well drained, aerated and enriched with organic matter.

Once the vegetation is removed:

1. water courses are swollen and laden with sediment during the rains and become low or dry during the remainder of the year;

2. soils become extremely susceptible to erosion, recycling of nutrients is impeded, leaching of nutrients increases and, as a result, fertility rapidly declines.

In Africa, 20 to 35 percent of the organic material in the soil can be lost during the first year after TMFs have been removed, and as much as 62 percent can be lost after several years of cultivation. Transport of sediments from areas covered with TMFs may be as low as 18 to 37 tons/km^2/year but reach more than 1,500 tons/km^2/year where forests have been removed (UNESCO/WHO, 1974). Conditions of rapid soil erosion not only have severe adverse effects for the people of the immediate region but also for agricultural, industrial, and urban areas far downriver (Goldman, 1979; Richards, 1973).

Nepal has been so badly denuded that topsoil, transported by water, is today that nation's leading export (Newsweek, 1980). In Kenya the value of annual topsoil loss now exceeds the country's gross national product (Brown and Wolf, 1984). In India, where more than 10,000 km^2 are deforested each year (Norman, 1982), six billion tons of topsoil are eroded away and lost per annum--ten tons for every person in that already poor country. To repair the flood damage in India costs, on average, about 250 million U.S. dollars a year. This is in addition to the loss of life, production, and livelihood (Spears, 1982).

> "The tragic destruction and staggering costs associated with deforestation in primary catchments have led many to call for the protection of remaining montane forest environments as either parks or equivalent reserves. . ."
> (Weber 1981)

A rapidly expanding human population and the mismanagement of TMFs have led to chronic shortages of fertile soil, food and clean water in many Africa countries. Since 1970, food production in Africa has declined, and net grain imports have quadrupled. Foreign grain now feeds about 25 percent of the continent's people. In spite of this massive input, half of Africa's countries are facing famine and one-fourth of the children already suffer from malnutrition (Brown and Wolf, 1984). The lack of clean water now accounts for 80 percent of all illness. In light of these enormous problems, we find that the standard of living is dropping faster in Africa than anywhere else (VOA interview with Lester Brown, Director of World Watch Institute, 1984).

TROPICAL MOIST FORESTS INFLUENCE LOCAL AND GLOBAL CLIMATES

It is now apparent that the widespread elimination of TMFs is contributing to changes in patterns of air circulation, wind currents and convection processes, and to increased carbon dioxide (Bolin, 1977; Stuiver, 1978; Woodwell, 1978) and particulate matter in the atmosphere (Myers, 1979; Righter, 1983). Two likely results of these changes are an average global increase in temperature of 2-3°C, and decreased rainfall (Charnev et al., 1975; Nicholson, 1936). These changes are occurring not only in the vicinity of the destroyed TMFs, but also in the equatorial zone as a whole and in the important food producing temperate regions of the world (Myers, 1979; Potter et al., 1975). Such global climate deterioration will be particularly disastrous to African nations where drought is already chronic and where people in twenty-one nations are expected to suffer hunger and malnutrition in 1984. We can also expect such changes to spur the advance southwards of the Sahara Desert . . . an advance which is already proceeding at the rate of 200 km/year.

TROPICAL MOIST FORESTS SERVE AS RESERVOIRS OF PLANTS AND ANIMALS FOR RECOLONIZATION OF EXPLOITED AREAS.

Intact TMFs act as reservoirs from which plants and animals can recolonize areas which have been felled, burnt or cultivated. These reservoirs provide insurance against the adverse effects of exploitation and mistakes in judgement. They serve as areas in which genetic resources are conserved and where the evolutionary process can continue unabated (Ahmad, 1979; Oldfield, 1981; Poore, 1974; Richards, 1973). Retaining areas of natural forest is the only way to reconstruct future forests (Gomez-Pompa et al., 1972).

TROPICAL MOIST FORESTS SERVE AS NATURAL LABORATORIES AND RESEARCH STANDARDS.

TMFs are the world's greatest living laboratories for the study of nature, evolution and the human environment . . . laboratories which are providing an understanding of the past and clues to the future (Budowski, 1981a; Oldfield, 1981; Richards, 1973).

Undisturbed TMFs are needed as standards against which to gauge the effects of forest exploitation, and assess losses and rates of recovery of damaged areas. Applied research conducted in unexploited TMFs can disclose additional human values of the TMF, yield information on the functioning of this ecosystem, and provide data on how to minimize the impact of exploitation on these areas and enhance their recovery. Such forests are also important training and demonstration grounds for foresters, agriculturalists, soil scientists, land-use planners, botanists, zoologists, ecologists, entomologists, hydrologists and others concerned with the maintenance, functions and values of complex natural systems.

TROPICAL MOIST FORESTS ARE RICH IN SPECIES AND THUS SERVE AS STOREHOUSES FOR GENETIC MATERIAL

Each year the world's people require more food, fiber, pharmaceuticals, and industrial products that owe their origin to wild species of plants and animals. We do not know what all of tomorrow's human needs will be . . . we do know, however, that they will be enormous and varied. We also know that many of these needs will be met only by species from TMFs . . . species which today provide no obvious benefit to man . . . species which have yet to be discovered and named.

One-half to two-thirds of the earth's five to ten million species of plants and animals live in TMFs (Myers, 1979). Of these, only about 16 percent have been identified, and only a very small number have been studied in detail (Allen, 1976; Myers, 1976, 1980). It is anticipated that before the end of this century we will cause the extinction of about one million species, primarily through the destruction of TMF habitats (Global 2000 Report; Myers, 1979).

It is irrational, short-sighted and unethical to cause the wholesale extinction of so many species . . . many of which could contribute invaluable services for enhancing the condition of mankind. As Harlan (1972) writes, "[we may all be] justifiably condemned by future generations for squandering our genetic heritage and theirs."

The spectrum of species must be recognized as among society's most valuable repositories of raw materials (Myers, 1976). Our future options to utilize TMF species to the service of humanity can only be guaranteed if their habitats are protected now (Oldfield, 1981; World Conservation Strategy, 1980).

TROPICAL MOIST FORESTS ATTRACT TOURISTS.

Properly managed tourism is the one form of commercial exploitation that is, up to a critical point, compatible with the concept of a protection forest (Weber, 1981).

Tourists, both local and foreign, are attracted to the myriad of interesting and beautiful forms of life to be found in the TMF . . . small numbers of very many species in contrast to the large numbers of a few species seen in savannahs. The potential for tourism in TMFs fully equals that of the savannahs (Allen, 1975). Today, more and more visitors are developing an interest in, and appreciation for, TMFs and the pleasant, infinite array of new sights, sounds and smells to be experienced there.

Tourism in TMFs serves three important functions. First, it yields foreign currency and creates local income. Second, it brings people from different places and cultures into contact with one another and, thus, helps to instill greater understanding and appreciation among nations. Third, TMFs contribute to the psychological and spiritual well-being of its visitors (Poore, 1974).

SERVICES WHICH EXPLOITED TROPICAL MOIST FORESTS PROVIDE TO MANKIND

TROPICAL MOIST FORESTS CAN OFTEN BE EXPLOITED ON A SUSTAINED BASIS FOR THE LONG-TERM BENEFIT OF MAN.

Such exploitation, however, must be scientifically based, carefully controlled, and conducted with a minimum of damage to the ecosystem. Far too often we find total destruction of the TMF. Total destruction is always extremely wasteful of the wealth of the TMF and closes long-term options for sustainable development . . . options from which everyone might have benefitted.

> Total destruction ". . . may produce immediate profits--often small, for a short time only, and only for some people, while for others, often very large numbers, it may imply a considerable loss--and for a considerable period. Most of the time it has led to residual waste-land such as degraded, man-made savannahs, and this can be witnessed in most of the tropical rain forest countries." (Budowski, 1981b)

TROPICAL MOIST FOREST PLANTS AND ANIMALS ARE AN IMPORTANT SOURCE OF GENETIC MATERIAL.

During the "Green Revolution," plant and animal genetecists have been extremely successful in increasing the yields of crops and livestock. This has been accomplished, however, at the sacrifice of genetic diversity. The narrow genetic base of most of today's important crops makes them highly vulnerable to factors which limit productivity (Harlan, 1975; Welsh, 1981). To help counteract such genetic vulnerability, genetecists are making vast collections of germ plasm from wild varieties (gene banks) so that breeders will have the genetic resources necessary not only for developing plants and animals which are more productive and nutritious, but also better able to cope with diseases, pests, low soil fertility and harsh weather (Plucknett et al., 1983a).

What is far more important than gene banks, however, is the conservation of the vast diversity of plants and animals in nature, particularly the wild progenitors of traditional cultivares and domestic livestock (Ahmad, 1979; Dahlberg, 1983; Global 2000 Report; Oldfield, 1981; World Conservation Strategy, 1980).

> "As much of the genetic diversity of crops and their wild relatives as possible should remain under natural conditions. In the case of wild species, parks and reserves are needed to ensure the survival of crop relatives."
> (Plucknett et al., 1983b)

Genetic resources from wild stock have already been used to broaden the genetic base and save such important crops as bananas, sugarcane, coffee, rice and maize. For many species, the wild stock persists only in TMFs. Increased productivity due to genetic improvement of United States crops alone is now estimated to be worth about 700 million U.S. dollars a year (Earthscan, 1982). Indeed, the recent discovery of a wild perennial species of corn in Mexico could, alone, when crossbreed with domesticated varieties, yield annual economic savings and benefits totalling more than 2.5 billion U.S. dollars (Myers, 1981).

Without the wild stock there is little chance of maintaining the Green Revolution which has benefitted so many of the world's people during the past two decades. Without the Green Revolution, we can expect 1.3 billion malnourished people in the Lesser Developed Countries in the year 2,000 (Global 2000 Report).

TMFs are also contributing immensely to our discovery and development of new cultivares, chemicals, medicines and industrial products. These include antibiotics, enzymes, hormones, narcotics, vitamins, contraceptives, gums, resins, oils, pesticides, fuels, fibers and waxes (Ayensu, 1983; Levingston & Zamora, 1983; Myers, 1979, 1980; Oldfield, 1981; Poulsen, 1982; Reisner, 1977).

About 50 percent of the drugs sold each year under prescription in the United States contain a drug of natural origin, often from the TMF (Farnsworth, 1977). This fact is all the more astonishing when one realizes that fewer than 6 percent of all plant species have been tested for pharmacologically active compounds (Myers, 1980).

Many research organizations feel that the widespread elimination of TMFs would represent a serious setback to their efforts to improve conditions for mankind. For example, the U.S. National Cancer Institute believes the loss of TMFs would greatly damage its anti-cancer campaign. Why? Because, of the 3,000 species of plants already known to possess anti-cancer properties, 70 percent come from the TMF (Myers, 1979). Many of the 1.5 to 3.5 million species of insects of the TMF also offer potential for anti-cancer compounds.

It is clear that any reduction in the world's spectrum of species narrows our possibilities and chances for dealing successfully with present and future problems.

> "Genetecists will argue that the best policy is to keep open the broadest possible range of options. And the first place to look for this feature is where the maximum diversity exists--the tropical moist forest."
> (Ahmad, 1979)

TROPICAL MOIST FORESTS YIELD WOOD FOR FUEL AND CONSTRUCTION.

TMFs have been referred to as the "green gold" of the Third World, providing twenty countries with their main export earning (Righter, 1983). But, everywhere this precious resource is being hacked away with little attempt at efficient exploitation with minimal damage to the ecosystem, or conservation of any kind. Three West African countries, once rich with TMFs, can now stand back and contemplate this frightening affair . . . Ivory Coast has already lost 67 percent of its TMF, Ghana more than 75 percent, and the Gambia 96 percent (Righter, 1983; Twum-Barima, 1981).

It is not only high quality timber that is becoming scarce. More than 90 percent of the wood cut in Africa is burned as fuel. Women in East Africa spend up to six days a week simply collecting cooking wood for their families. In West Africa it often costs more to heat a pot than to fill it with food (Newsweek, 1980).

APPENDIX B

DESCRIPTIONS OF THE NATURE RESERVES

ISHASHA RIVER NATURE RESERVE

The nature reserve in the North Sector of the Impenetrable is situated near the centre of the Sector just north of Katojo Hill and much of its north and east boundary is formed by the Ishasha River. I will refer to this area as the Ishasha River Nature Reserve (Figure 12) (Butynski, 1984).

This nature reserve is well placed as it includes habitats in a catena from valley bottom to hilltop (i.e., from the Ishasha River at 1,280 m to the top of Katojo Hill at 1,680 m). Protection is provided to c. 3 km^2 of the Ishasha Gorge, an area of particular importance for a number of tree species not found elsewhere in East Africa (Hamilton, 1974). This is expected to be a critically important area for other taxa of plants and animals but inventories have yet to be made. For so small an area, it includes a good number of forest types, six in all (Cahusac, 1958).

NTENDURE HILL NATURE RESERVE

The nature reserve in the South Sector of the Impenetrable is about 10 km^2 and is located near the north-central part of the Sector just to the north of Ntendure Hill. It includes parts of the watersheds of the Mbwa, Rugyezi, Ntendure, Ihihizo and Hayomugando Rivers from which water flows to Lake Edward. Catenas extend from the above mentioned rivers (1,830 - 2,010 m) to the top of Ntendure Hill (2,165 m). I will refer to this area as the Ntendure Hill Nature Reserve (Figure 12) (Butynski, 1984).

The Ntendure Hill Nature Reserve is also well situated. It includes six forest types (Cahusac, 1958). In addition, it probably contains all seven species of the diurnal primates which occur in the Impenetrable (the one questionable species is the redtail monkey, but the local people assured me that it is here).

APPENDIX C

TYPES OF TRAPS USED BY POACHERS IN THE IMPENETRABLE FOREST

Poachers in the Impenetrable Forest use five distinct types of animal traps.

TRIGGERED LEG SNARES: A pit about 25 cm deep and 25 cm square is dug along a game trail. A 15 cm diameter loop made of stout bushrope or wire cable is placed horizontally in the pit and attached to a triggering device. The loop is also attached to a strongly bent, freshly cut, 4 m long pole which has been stuck into the ground about 3 m from the game trail. The pit, loop, and triggering device are then concealed with twigs and leaves. As with all snare-type traps described here, sticks and logs are usually placed so as to "guide" the animal into the trap. An animal walking along the trail steps into the pit and sets-off the trigger. The bent pole then springs tightening the loop around the animal's leg.

Triggered leg snares are set primarily for duiker, bushbuck, bushpig and giant forest hog. During this survey a butchered duiker was located 4 m from one such trap, and the trampled areas around two other traps indicated that they had caught bushpigs. Traps of this type are probably most damaging to the wildlife of the Reserve because (1) they catch the larger and least common animals, (2) they are frequently used, and (3) they are also capable of capturing and holding chimpanzees and gorillas. Those chimpanzees and gorillas which do break loose from these traps eventually die or are badly maimed as a result of the snare which remains tight around the leg.

TRIGGERED NECK SNARES: These traps are set on logs which have fallen across large streams. Animals use these logs to cross from one bank of the stream to the other. A 15 cm diameter loop made from bushrope is placed vertically about 25 cm above the log. The loop is attached to a triggering device and to a small bent sapling on the stream bank. An animal walking the log places its head through the loop, which then tightens around the neck. This sets off the triggering device, the sapling springs, and the animal is lifted into the air and strangles. I was told that these traps are set primarily for monkeys (probably lhoesti monkeys and blue monkeys), but it is likely that they also catch similar sized mammals such as otters, golden cats, civets and genets.

ANTELOPE SNARES: This snare consists only of a 25 cm diameter loop of bushrope or wire cable attached to a sapling. No triggering or springing devices are used. The loop is suspended vertically at a height of 50-75 cm over a well used game trail. The animal puts its head through the loop which then self-tightens around the neck. The size and height of the loop suggests that these traps are set primarily for bushbuck and duiker, but they undoubtedly catch many other species, including chimpanzees and gorillas. This is probably the most common type of trap used by poachers in Kibale Forest, where 15 to 20 percent of the adult chimpanzees have lost digits or hands as a result of traps (Ghiglieri, unpubl. data).

FOWL SNARES: These are similar to the "antelope snares" except the loop is of thin bushrope, is but 8 cm in diameter and suspended at a height of about 16 cm. This snare is probably incapable of catching and holding many animals other than guinea fowl and francoline.

DEADFALLS: Deadfall traps consist of a narrow chute with one end blocked off. The walls of the chute are of verticle poles pushed or dug into the ground. The animal must enter the trap to obtain a bait which is attached to a triggering device. An attempt to remove the bait sets off the triggering device, and several large logs collapse onto the animal.

Only four deadfall traps were located during this survey. One was small and apparently designed to catch monkeys, and the others were large and probably for pigs. Deadfall traps are highly indiscriminate in the animals they kill. The larger deadfalls are capable of killing chimpanzees and gorillas. This was the least common type of trap in the Reserve.

APPENDIX D

MAMMALS OF THE IMPENETRABLE FOREST, UGANDA

COMMON NAME	SCIENTIFIC NAME
PRIMATES	**PRIMATES**
Potto	*Perodicticus potto*
Demidoff's Galago	*Galago demidovii*
Needle-clawed Galago	*Galago inustus*
Redtail Monkey	*Cercopithecus ascanius*
Blue Monkey	*Cercopithecus mitis*
L'Hoest's Monkey	*Cercopithecus l'hoesti*
Black and White Colobus	*Colobus abyssinicus*
Olive Baboon	*Papio anubis*
Chimpanzee	*Pan troglodytes*
Mountain Gorilla	*Gorilla gorilla*
HYRAXES	**HYRACOIDEA**
Tree Hyrax	*Dendrohyrax arboreus*
PANGOLINS	**PHOLIDOTA**
Giant Pangolin	*Manis gigantea
Tree Pangolin	*Manis triscuspis
AARDVARK	**TUBULIDENTATA**
Aardvark	*Orycteropus afer*
INSECIVORES	**INSECTIVORA**
Giant Otter Shrew	*Potamogale velox
Dwarf Otter Shrew	*Micropotamogale ruwenzorii
Golden Mole	*Chrysochloris stuhlmanni*
Mouse Shrew	*Myosorex blarina*
Long-tailed Forest Shrews	*Sylvisorex lunaris
	Sylvisorex granti
	Sylvisorex megalura
Hero Shrew	*Scutisorex somereni*
Rodent Shrew	*Paracrocidura schoutedeni
White-toothed Shrews	*Crocidura flavescens*
	Crocidura maurisca
BATS	**CHIROPTERA**
Egyptian Rousette Bat	*Rousettus aegyptiacus
Mountain Fruit Bat	*Stenonycteris lanosus*

*Species probably occurs

Angolan Fruit Bat	Lissonycteris angolensis
Little Collared Fruit Bat	Myonycteris torquata
Straw-colored Fruit Bat	*Eidolon helvum
African Epauletted Bats	*Epomophorus anurus
	*Epomophorus labiatus
Dwarf Epauletted Bat	Micropteropus pusillus
Franquet's Fruit Bat	Epomops franqueti
Hammer Bat	Hypsignathus monstrosus
Nectar Bat	Megaloglossus woermanni
Black-hawk Bats	*Taphozous peli
	*Taphozous mauritianus
Slit-faced Bats	Nycteris hispida
	Nycteris macrotis
	Nycteris nana
	*Nycteris grandis
	*Nycteris arge
	*Nycteris thebaica
Yellow-winged Bat	*Lavia frons
Horseshoe Bats	Rhinolophus alcyone
	Rhinolophus landeri
	*Rhinolophus fumigatus
Cyclops Bat	Hipposideros cyclops
African Leaf-nosed Bats	Hipposideros caffer
	*Hipposideros ruber
Mouse-eared Bat	*Myotis bocagei
Pipistrelles	Pipistrellus nanus
	*Pipistrellus nanulus
Serotines	Eptesicus tenuipinnis
	*Eptesicus capensis
Moloney's Flat-headed Bat	Mimetillus moloneyi
Twilight Bat	*Nycticeius hirundo
House Bat	Scotophilus nigrita
Butterfly Bats	*Glauconycteris argentata
	*Glauconycteris superba
	*Glauconycteris variegata
Chaerephon Free-tailed Bats	Tadarida pumila
	*Tadarida aloysiisabaudiae
	*Tadarida cistura
Mops Free-tailed Bats	Tadarida condylura
	Tadarida nanula
	*Tadarida thersites
Giant Mastiff Bat	Otomops martiensseni
HARES	**LAGOMORPHA**
Crawshay's Hare	Lepus crawshayi
RODENTS	**RODENTIA**
Cuvier's Fire-footed Squirrel	Funisciurus pyrrhopus
Carruther's Mountain Squirrel	Funisciurus carruthersi
Boehm's Squirrel	Funisciurus boehmi
Alexander's Dwarf Squirrel	*Funisciurus alexandri
Ruwenzori Sun Squirrel	Heliosciurus ruwenzorii

Red Legged Sun Squirrel	Heliosciurus rufobrachium
African Giant Squirrel	Protoxerus stangeri
Lord Derby's Anomalure	Anomalurus derbianus
Root Rat	Tachyoryctes splendens
Climbing Mice	Dendromus melanotis
	Dendromus mesomelas
	Dendromus mystacalis
Link Rat	*Deomys ferrugineus
Giant Pouched Rats	Cricetomys gambianus
	*Cricetomys emini
Delany's Mouse	*Delanymys brooksi
Groove-toothed Rats	Otomys denti
	Otomys irroratus
	Otomys typus
Rat	Rattus rattus
Multimammate Rat	Praomys natalensis
Soft-furred Rat	Praomys jacksoni
African Wood Mice	Praomys denniae
	Praomys stella
	*Praomys aeta
Mice	Mus bufo
	Mus minutoides
	Mus triton
Shaggy Swamp-rat	Dasymys incomtus
Mill Rat	*Mylomys dybowski
One-striped Forest Mouse	Hybomys univittatus
Striped Grass Mice	*Limniscomys macculus
	Limniscomys striatus
Creek Rat	Pelomys isseli
Unstriped Grass Rat	Arvicanthis niloticus
Broad-footed Thicket Rats	Thamnomys rutilans
	Thamnomys venustus
Narrow-footed Thicket Rat	Grammomys dolichurus
Rusty-nosed Rat	Oenomys hypoxanthus
Brush-furred Mice	Lophuromys sikapusi
	Lophuromys flavopunctatus
	Lophuromys woosnami
Velvet Rat	*Colomys goslingi
Long-footed Rat .	Malacomys longipes
African Dormouse	Graphiurus murinus
Brush-tailed Porcupine	*Atherurus africanus
South African Porcupine	*Hystrix africae-australis
Crested Porcupine	*Hystrix cristata
Savanna Cane-rat	Thryonomys gregorianus
UNGULATES	ARTIODACTYLA
Bushpig	Potamochoerus porcus
Giant Forest Hog	Hylochoerus meinertzhageni
Black-fronted Duiker	Cephalophus nigrifrons
Yellow-backed Duiker	Cephalophus sylvicultor
Red Duiker	*Cephalopus callipygus
Blue Duiker	*Cephalopus monticola

Angolan Fruit Bat	Lissonycteris angolensis
Little Collared Fruit Bat	Myonycteris torquata
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	*Nycteris arge
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	Otomys irroratus
	Otomys typus
Rat	Rattus rattus
Multimammate Rat	Praomys natalensis
Soft-furred Rat	Praomys jacksoni
African Wood Mice	Praomys denniae
	Praomys stella
	*Praomys aeta
Mice	Mus bufo
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	Mus triton
Shaggy Swamp-rat	Dasymys incomtus
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Rusty-nosed Rat	Oenomys hypoxanthus
Brush-furred Mice	Lophuromys sikapusi
	Lophuromys flavopunctatus
	Lophuromys woosnami
Velvet Rat	*Colomys goslingi
Long-footed Rat	Malacomys longipes
African Dormouse	Graphiurus murinus
Brush-tailed Porcupine	*Atherurus africanus
South African Porcupine	*Hystrix africae-australis
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UNGULATES	ARTIODACTYLA
Bushpig	Potamochoerus porcus
Giant Forest Hog	Hylochoerus meinertzhageni
Black-fronted Duiker	Cephalophus nigrifrons
Yellow-backed Duiker	Cephalophus sylvicultor
Red Duiker	*Cephalopus callipygus
Blue Duiker	*Cephalopus monticola

White-bellied Duiker	*Cephalophus leucogaster
Bushbuck	Tragelaphus scriptus
African Buffalo (extinct)	Syncerus caffer
ELEPHANT	PROBOSIDEA
African Elephant	Loxodonta africana
CARNIVORES	CARNIVORA
Spotted-necked Otter	*Lutra maculicollis
Cape Clawless Otter	*Aonyx capensis
Congo Clawless Otter	Aonyx congica
Servaline Genet	Genetta servalina
Large-spotted Genet	Genetta tigrina
Giant Genet	*Genetta victoriae
African Civet	Viverra civetta
Two-spotted Palm Civet	Nandinia binotata
Egyptian Mongoose	*Herpestes ichneumon
Slender Mongoose	Herpestes sanguineus
Marsh Mongoose	Atilax paludinosus
Banded Mongoose	Mungos mungo
Alexander's Cusimanse	*Crossarchus alexandri
Leopard	Panthera pardus
African Wild Cat	*Felis sylvestris
Golden Cat	Profelis aurata
East African Serval	*Felis serval

APPENDIX E

NATIONAL PARKS: GOALS AND PRINCIPLES

THE MOST IMPORTANT GOAL FOR MOST NATIONAL PARKS IS THE MAXIMIZATION OF THE NUMBER OF SPECIES CONTAINED THEREIN AND THE SUSTAINED, LONG-TERM MAINTENANCE OF THESE SPECIES.

From the point of view of ecology, national parks should be established so as to preserve ecological functions and maximize the diversity of ecological interaction (Frankel and Soulé, 1981). Since the diversity of interactions is directly correlated with the number of species, the premier goal of national parks becomes the maximization of the number of species and the maintenance of these species (Cole, 1981; Terborgh, 1976).

THE DESIGN OF NATIONAL PARKS: FIVE GENERAL PRINCIPLES FROM ECOLOGY AND GENETICS.

Natural processes cause plant and animal communities to become fragmented and eventually isolated from others of their kind. In more recent times this process has been augmented by the additional influences of man, the results being a considerable reduction in the size of the fragments and an increase in their degree of isolation. Man-caused disruptions, therefore, have important implications for the establishment of national parks. "When a protected area is set aside, it is almost certainly destined to become an island of undisturbed nature in a sea of man-dominated, and hence alien, environments." (Myers, 1979).

The fact that most national parks are essentially biotic islands has given rise to a considerable body of research on how national parks and other protected areas can best be designed so as to enhance the long-term survival of the natural communities contained therein. Below, I present some of the more important principles that apply to the proper design of national parks.

PRINCIPLE 1: NATIONAL PARKS SHOULD BE AS LARGE AS POSSIBLE.

There is a prevalent principle in ecology concerning the design of national parks. This principle states that the number of different species an area can support depends primarily on its size. The larger the area, the more species (MacArthur and Wilson, 1967). As it relates to the design of national parks, the conclusion is that national parks should be as large as is feasible (Cole, 1981; Diamond, 1975, 1976; Margules and Usher, 1981; Terborgh, 1975, 1976; Whitcomb et al., 1976). It should be noted that habitat diversity (Principle 2), avoidance of genetic deterioration (Principle 3), and reduced human disturbance (Principle 4), are all enhanced by establishing the largest possible national parks.

PRINCIPLE 2: NATIONAL PARKS SHOULD CONTAIN AS MANY DIFFERENT KINDS OF HABITATS AS POSSIBLE.

The number of species present in a national park is enhanced by ensuring that the area encompasses and retains a large number of different habitat types (Foster, 1980; Pickett and Thompson, 1978). In other words, species diversity increases with increased habitat diversity, and habitat diversity generally increases with the size of the national park.

PRINCIPLE 3: NATIONAL PARKS SHOULD INCLUDE AS MANY INDIVIDUALS OF EACH SPECIES AS POSSIBLE.

Species which are comprised of a low number of individuals are highly susceptible to several processes (such as inbreeding), which lead to the genetic debilitation of the population and eventual extinction (Ballou and Ralls, 1982; Frankel and Soulé, 1981; Miller, 1979). All familiar with this problem agree that many of today's national parks are far too small for the long-term avoidance of genetic deterioration of their plant and animal species, particularly the larger species which are generally represented by the lowest numbers of individuals. The consensus here is that national parks must be as large as is feasible so as to encompass as many individuals of each species as possible.

PRINCIPLE 4: NATIONAL PARKS SHOULD BE RELATIVELY FREE OF HUMAN DISTURBANCE.

Reductions in the numbers of species leads to instability within the ecological community, and this, in turn, can result in further extinctions (Gomez-Pompa et al., 1972; Robinson, 1979). This is particularly true for tropical moist forests which are exceptionally rich in species yet particularly sensitive to habitat disturbance and destruction, both natural and man-made (Eisenberg, 1980; Foster, 1980; Janzen, 1972; Terborgh, 1975). To exemplify this point, Raven (1976) estimates that the loss of a single plant species in a tropical forest can set in motion a cascade of extinction resulting in the loss of ten to thirty species of animals.

Because of this susceptibility to disturbances, national parks must be established which are both very large and relatively free of human activities. In many cases, human interference must be limited to scientific research and perhaps tourism.

Frankel and Soulé (1981) emphasize the problem of human disturbance in tropical forests and its incompatibility with species preservation,

> "Reserves, or at least their core areas, should be inviolate in the tropics because of the exacting structural requirement of many tropical species and the vulnerability of tropical forests. The multiple-use concept, developed by and for temperate forests, might be disastrous in the tropics because of the fragility of soils and the exacting ecological requirements of many species."

I might add here that the multiple-use concept is not always applicable to the tropical forest because of the high degree of understanding, control and supervision that is required to exploit tropical forests without significantly reducing their conservation values. Harcourt (1981) found this point particularly applicable to the present situation in the Impenetrable Forest,

> ". . . the success of a management plan allowing partial use of a conservation area depends on maintenance of very tight control over exploitation. In the case of the Bwindi Forest, this is not being provided at present and will always be difficult to ensure."

PRINCIPLE 5: LOCAL MIGRATION CORRIDORS SHOULD BE ESTABLISHED WHEREVER POSSIBLE.

Migration corridors between national parks or sectors of the same national park should be established wherever feasible (Diamond, 1975; Frankel & Soulé, 1981; MacClintock, et al., 1977; Poore, 1974). Such corridors permit a continuous exchange of individuals and genes between areas. This helps to increase the habitat available to some species and reduces the genetic depression of some populations.

Corridors are particularly important for tropical forests where the vast majority of species are extremely sedentary and will not cross even small stretches of non-forested land (Diamond, 1975; Terborgh, 1975). This even applies to many apparently mobile animals such as birds, bats and winged insects. For example, 98 percent of the forest birds occurring in the Impenetrable Forest are sedentary and practically never leave the forest habitat (Keith, 1980). Some of these species probably even find a 5 m wide logging road an insurmountable barrier.

SUMMARY.

The primary goal of most national parks is to maximize the number of species contained therein. This goal is likely to be most successfully achieved where (1) a large array of habitat types are retained, (2) where habitat corridors are established, (3) where large numbers of individuals of each species are maintained, (4) where disturbances caused by human activities are minimized and (5), most importantly, where large tracts of land are incorporated into national parks.